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DEPARTMENT OF THE ARMY TECHNICAL MANUAL

OPERATOR, ORGANIZATION, DS, GS AND DEPOT MAINTENANCE MANUAL

TEKTRONIX OSCILLOSCOPE TYPE 543

HEADQUARTERS, DEPARTMENT OF THE ARMY

SEPTEMBER 1966

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FOREWORD

This is a first-edition manual containing preliminary and unreviewed information compiled by the manufacturer of the equipment. Judicious caution should be exercised in using the information in this manual until it is replaced by a revised edition.

Index of Equipment Publications

Refer to the latest issue of DA Pam 310-4 to determine whether there are new editions, changes, or additional publications pertaining to the equipment. Department of the Army Pamphlet No. 310-4 is a current index of technical manuals (types 7, 8, and 9), supply bulletins, lubrication orders, and modification work orders available through publication supply channels. The index lists the individual parts (-10, -20, -35P, etc) and the latest changes to and revisions of each equipment publication.

Forms and Records

Reports of Maintenance and Unsatisfactory Equipment. Use equipment forms and records in accordance with instructions in TM 38-750.

Report of Damaged or Improper Shipment. Fill out and forward DD Form 6 (Report of Damaged or Improper Shipment) as prescribed in AR 700-58 (Army), NAVSANDA Publication 378 (Navy), and AFR 71-4 (Air Force).

Reporting of Equipment Manual Improvements. The direct reporting of errors, omissions, and recommendations for improving this equipment manual by the individual user is authorized and encouraged. DA Form 2028 will be used for reporting these improvements. This form may be completed by using pencil, pen, or typewriter. DA Form 2028 will be completed by the individual using the manual and forwarded direct to Commanding General, U. S. Army Electronics Command, ATTN: AMSEL-MR-NMP-AD, Fort Monmouth, New Jersey 07703.

Focus and Astigmatism Controls

The FOCUS and ASTIGMATISM controls operate in conjunction with each other to allow you to obtain a sharp, clearly defined spot or trace. The proper setting of the ASTIGMATISM control is obtained by rotating the FOCUS control fully clockwise, setting the HORIZONTAL DISPLAY switch at EXT., the EXTERNAL HORIZONTAL VOLTS/CM at 10, and adjusting the INTENSITY control to obtain a spot on the screen. After positioning the spot to the center of the screen, the ASTIGMATISM control is adjusted for the most nearly circular spot possible. The FOCUS control is then adjusted to reduce the spot diameter as much as possible. You must be certain that all input signals to the oscilloscope are disconnected when you adjust the FOCUS and ASTIGMATISM controls.

Intensity Control

The INTENSITY control is used to adjust the brightness of the oscilloscope display. This permits you to compensate for changes in brightness resulting from changes in the sweep triggering rate. The INTENSITY control is rotated clockwise to increase brightness and counterclockwise to decrease it. Be careful when you use the INTENSITY control that the brightness is not turned up to where it will permanently damage the face of the cathode-ray tube. If brightness is turned up to the point where a halo forms around the spot, it should be turned down immediately.

Graticule Illumination Control

The graticule used with the Type 543/543A Oscilloscope is accurately marked with 10 horizontal and 6 vertical 1-centimeter divisions with 2-millimeter markings on the centerlines. These graticule markings allow you to make time and voltage measurements from the oscilloscope screen.

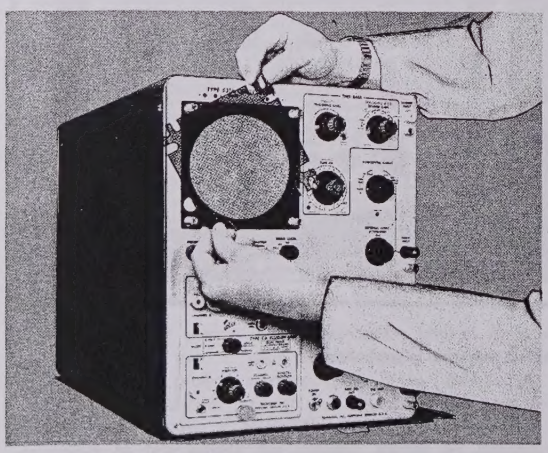


Fig. 2-5. Rotating the graticule to change the color of the graticule markings.

The graticule is illuminated by two lamps located at the top edge of the graticule. The graticule markings can be made either white or red by positioning the graticule so that either the clear bulb slots or those with red plastic inserts are next to the bulbs. Generally, the white graticule markings are better than the red for photographic purposes.

Graticule illumination is adjusted by the SCALE ILLUM. control located just under the oscilloscope screen. Rotating the control clockwise increases the brightness of the graticule markings, and turning it counterclockwise decreases brightness. For convenience in photographing oscilloscope displays, the SCALE ILLUM. control is marked in approximate f-stops. These f-stops can be used with a shutter speed of 1 second when TRI-X film is used, or with a shutter speed of 10 seconds when Polaroid film is used. Regardless of the type of film used, better results can generally be obtained with white graticule markings. For best results, try to match the intensity of the trace with the brightness of the graticule markings.

Positioning Controls

Three controls are used with the Type 543/543A for positioning the trace on the oscilloscope screen. Two controls are used to set horizontal positioning of the trace. These are located on the front panel of the instrument. The third control is used to set vertical positioning, and is located on the front panel of the plug-in unit used with the oscilloscope. The Type 53/54C and Type CA Dual-Trace Plug-In Units have two VERTICAL POSITION controls.

The two HORIZONTAL POSITION controls cause the trace to move to the right when they are rotated in the clockwise direction and to the left when rotated counterclockwise. Together, the two controls have a total positioning range of 12 to 1200 centimeters, depending upon the degree of sweep magnification used. The black HORIZONTAL POSITION control has approximately three times the range of the red VERNIER control. The fine range of adjustment of the VERNIER control makes this control particularly useful whenever fine horizontal positioning is required, such as when various positions of sweep magnification are used.

The VERTICAL positioning control has enough range to allow the trace to be positioned completely off the top or bottom of the screen or anywhere in between. The trace moves up when the control is turned clockwise and down when the control is turned counterclockwise.

Beam Position Indicators

Four small indicator lights located just above the oscilloscope screen indicate the position of the spot or trace. When one of these lamps is lit, it indicates that the trace is off-centered in the direction of the arrow. These four lights allow you to position the spot to the center of the screen even though the intensity is so low that the trace is not visible. When the sweep is running, the spot moves from the left side of the screen to the right and may cause both horizontal lamps to light each time the sweep runs.

Input Signal Connections

The electrical waveform to be observed is applied to one of the plug-in unit input connectors. The waveform is then connected through the vertical-deflection system of the plug-in unit and the oscilloscope to cause the spot to be deflected vertically and to trace out the waveform on the screen of the crt. The vertical size of the displayed waveform is adjusted with the plug-in unit VOLTS/CM switch. The VOLTS/CM switch is an accurately calibrated control which, when used with the graticule, allows you to make precise voltage measurements from the displayed waveforms. The operation of other plug-in unit controls varies between plug-in units. For information regarding the operation of these controls, refer to the instruction manual for the plug-in unit you are using.

Certain precautions must be taken when you are connecting the oscilloscope to the input signal source to insure that accurate information is obtained from the oscilloscope display. This is particularly true when you are observing low-level signals or waveforms containing high or extremely low frequency components. For applications where you are observing low-level signals, unshielded input leads are unsatisfactory because they tend to pick up stray signals which produce erroneous oscilloscope displays. Shielded cables should be used whenever possible, with the shield connected to the chassis of both the oscilloscope and the signal source. Regardless of the type of input lead used, keep them as short as possible.

Distortion of the input waveform may result if very low-frequency input signals are ac coupled into the oscilloscope, if high-frequency waveforms are not properly terminated, or if the input waveform contains high-frequency components which exceed the passband of the oscilloscope and plug-in unit combination. You must be aware of the limitations of the instrument.

In analyzing the displayed waveform, you must consider the loading effect that the oscilloscope has on the input signal source. In most cases this loading effect is negligible, but in some applications, loading caused by the oscilloscope may materially alter the results obtained. In such cases you may want to use a probe to reduce the amount of loading.

Use of Probes

Occasionally, connecting the input of an oscilloscope to a signal source loads the source enough to adversely affect both the operation of the source and the waveform displayed on the oscilloscope. When this occurs, both

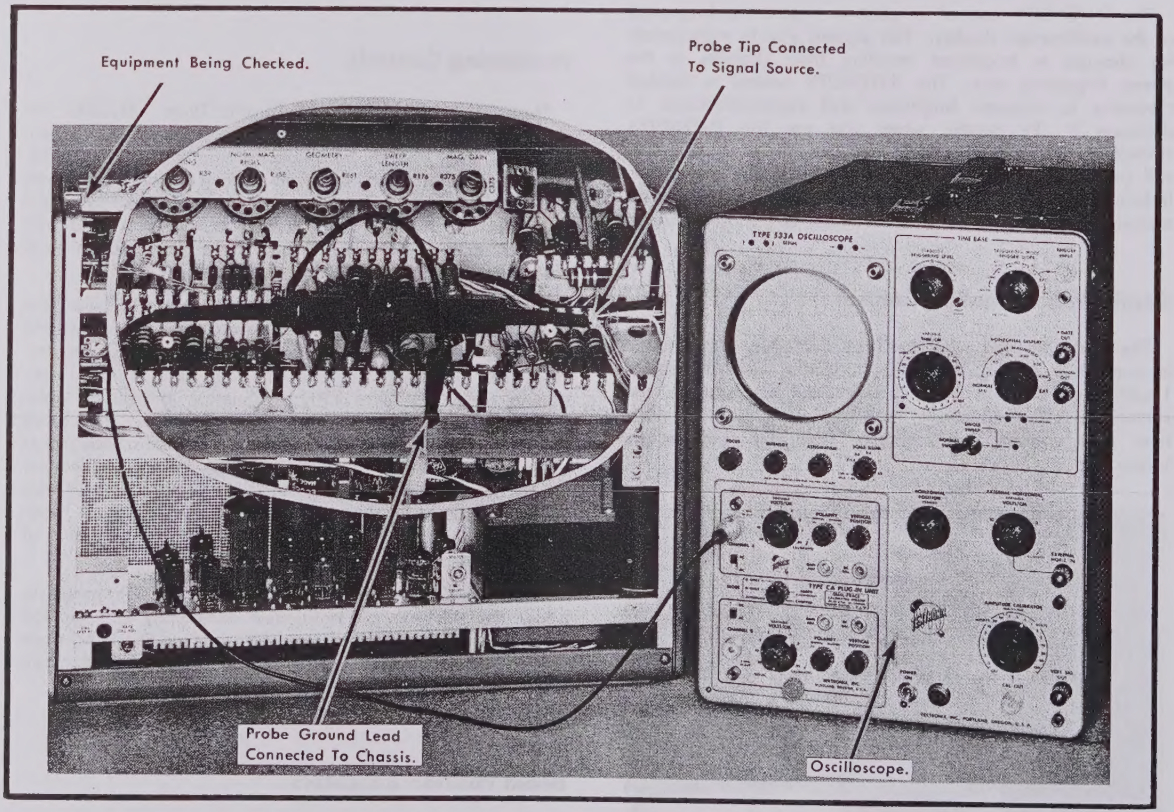


Fig. 2-6. Proper connection of a probe to the input signal source.

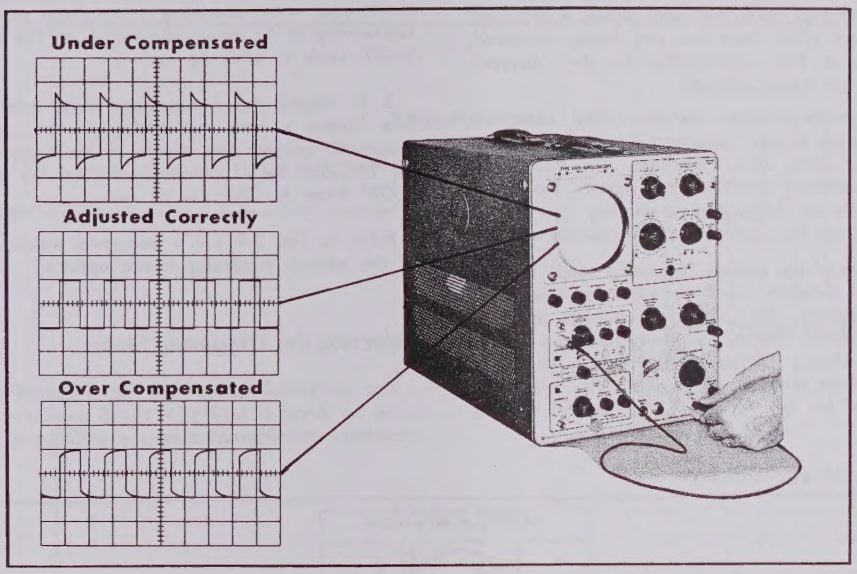


Fig. 2-7. When compensating the probe, it is adjusted to obtain an undistorted presentation of the calibrator square-wave.

capacitive and resistive loading due to the oscilloscope can be reduced to a negligible value by using an attenuator probe.

In addition to providing isolation of the oscilloscope from the signal source, an attenuator probe also decreases the amplitude of the displayed waveform by the attenuation factor of the probe. Use of a probe allows you to increase the vertical deflection factors of the oscilloscope to look at large amplitude signals which are beyond the normal limits of the oscilloscope and plug-in combination. Signal amplitudes, however, must be limited to the maximum allowable value of the probe used.

Before using a probe, you must check (and adjust if necessary) the compensation of the probe to prevent distortion of the applied waveform. To adjust the probe compensation, place the HORIZONTAL DISPLAY switch at NORMAL (X1), the TIME BASE TRIGGERING MODE switch to AUTOMATIC, and the TIME BASE TRIGGER SLOPE switch to +INT. Turn up the intensity until the trace is visible and connect the probe tip to the CAL OUT connector. Set the AMPLITUDE CALIBRATOR switch for 2 centimeters of displayed signal. Set the TIME BASE TIME/CM switch to display approximately 3 or 4 cycles of the Calibrator waveform and adjust the probe compensation control to obtain flat tops on the displayed Calibrator square waves as shown in Fig. 2-7.

The method of setting the compensation control depends on the probe in use. If your oscilloscope is equipped with a Type P510A probe, compensation is by means of a screwdriver adjustment through the hole near the nose end of the probe body. If a P6000 type probe is used, it is necessary to first unlock the Locking Sleeve by turning it counterclockwise. The probe is then compensated by rotating the probe body while watching the oscilloscope display for the desired waveform. When compensation is completed, carefully turn the Locking Sleeve clockwise to lock it without disturbing the adjustment of the probe.

HORIZONTAL DEFLECTION SYSTEM

Triggered Operation

For most uses of the oscilloscope a stable display of some waveforms is required. To accomplish this the oscilloscope can be operated so that the horizontal sweep

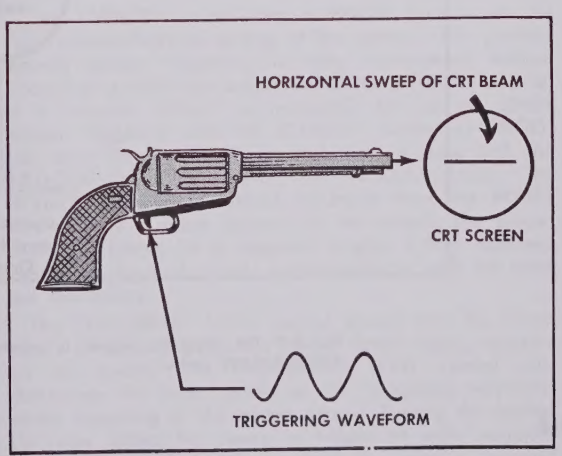


Fig. 2-8. In triggered sweep operation the horizontal sweep is started by the triggering waveforms.

starts at a given point on the displayed waveform. This is known as "triggered" operation. For the present, we will refer to the starting of the sweep, at the left side of the graticule, as "triggering" the sweep.

Triggered operation is useful for observing a waveform which may occur only once, or which may occur at random intervals. For any of these uses, the oscilloscope can be used in such a way that each horizontal sweep is triggered by some waveform other than the one being observed, but which bears a time relationship to the observed waveform.

The waveform used to start the horizontal sweep is called the "triggering signal", whether it is the waveform being observed, or some other waveform. The instructions that follow tell you how to select this signal. They also contain information on triggering according to various modes, depending on the nature of the triggering signal.

The nomenclature of the various Triggering Mode settings has been changed between the Type 543 and Type 543A Oscilloscopes. However, the switches themselves are the same. In the following descriptive paragraphs, the names of the Triggering Modes will be given for both Type 543 and Type 543A where the differences exist. The first name given will be that for the Type 543, the second for the Type 543A.

Selecting the Triggering Signal

1. To trigger the sweep from the waveform being observed, set the black TRIGGER SLOPE knob to INT. (+ or —).

2. To trigger the sweep from the powerline wave (as in the case when observing a waveform which has a time relationship to the power-line wave), set the black TRIGGER SLOPE knob to LINT (+ or —).

3. To trigger the sweep from some external waveform (one having a time relationship to the waveform being observed), connect the source of the triggering signal to the TRIGGER INPUT connector and set the black TRIGGER SLOPE knob to LINE (+ or —).

Refer to Fig. 2-9 for a complete pictorial presentation of the various triggering source options.

Selecting the Triggering Slope

The horizontal sweep can be triggered on either the rising (+ slope) or falling (— slope) portion of the triggering waveform as determined by the position of the TRIGGER

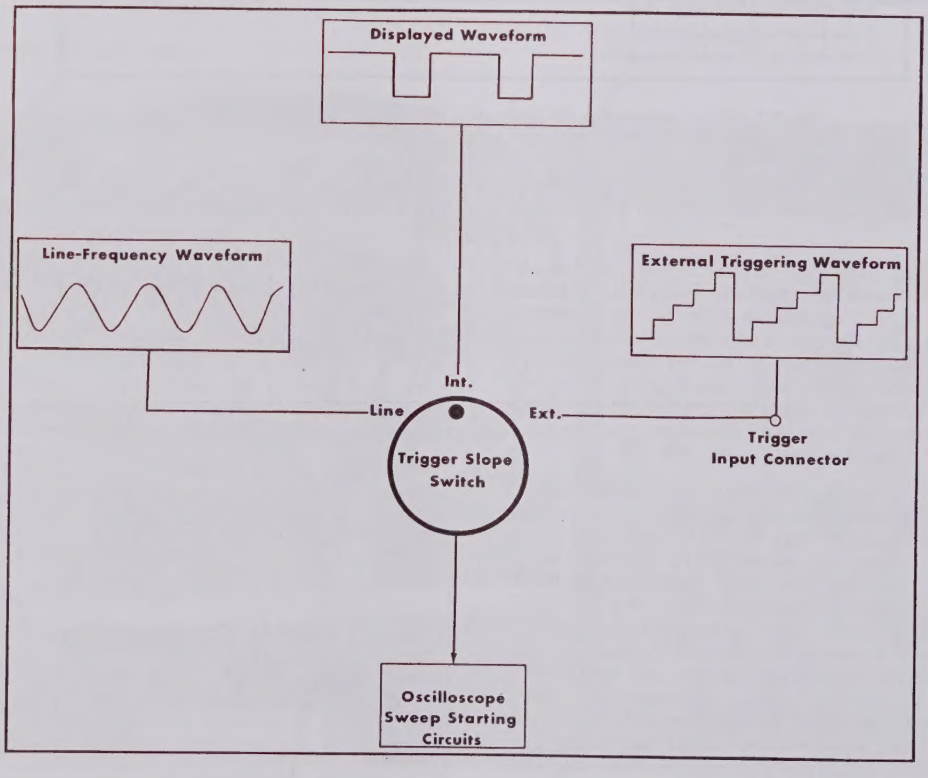


Fig. 2-9. The triggering signal is selected from three possible sources with the TRIGGER SLOPE control.

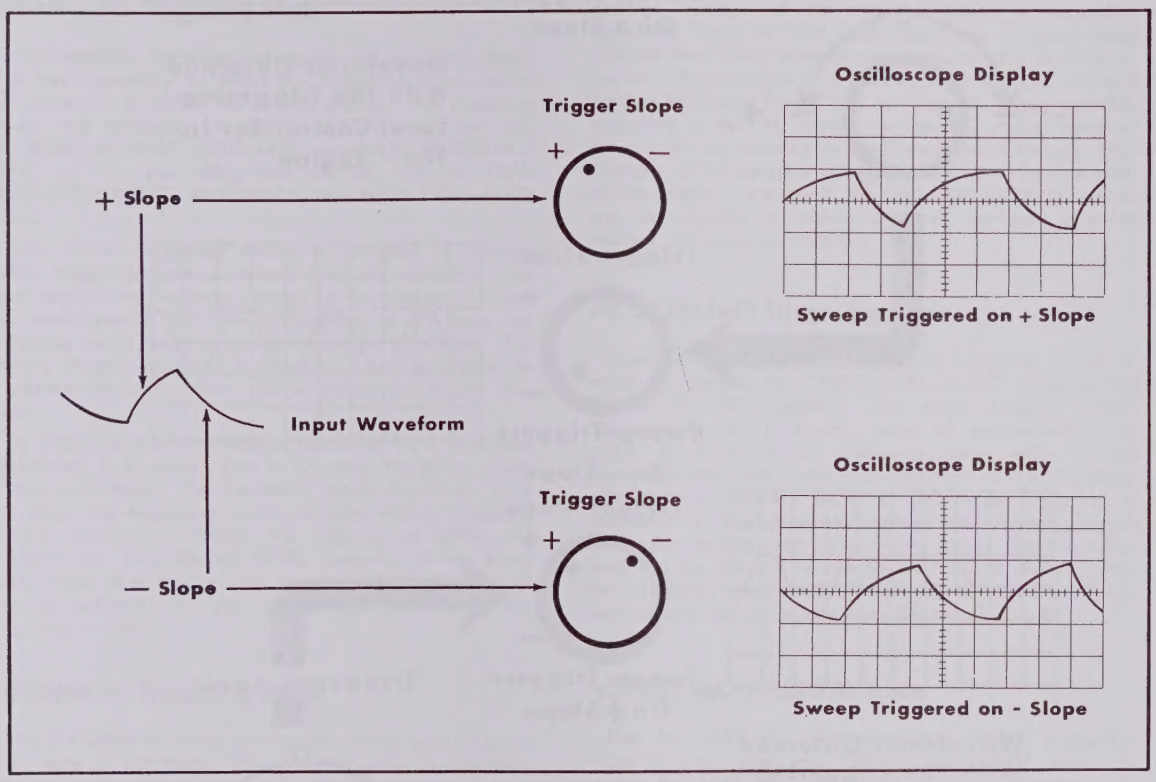


Fig. 2-10. Effects on the oscilloscope display produced by + and — settings of the TRIGGER SLOPE control.

SLOPE switch. When the switch is in one of the + positions, the sweep is triggered on the rising portion of the triggering waveform; when the TRIGGER SLOPE switch is in one of the — positions, the sweep is triggered on the falling portion of the waveform (See Fig. 2-10).

In many applications the triggering slope is not important, since triggering on either slope will provide a display which is suitable to the application. However, in many other cases such as pulse measurements, the triggering slope is very important. If, while using a fast sweep, you wish to see the rise of a pulse, it will be necessary for you to trigger the sweep on the rising portion of the waveform by placing the TRIGGER SLOPE switch in one of the + positions. To observe the fall of a pulse at a fast sweep speed, it will be necessary to trigger the sweep on the falling portion of the waveform by placing the TRIGGER SLOPE switch on one of the — positions. In either case, selection of the wrong triggering slope will make it impossible for you to see the portion of the waveform you want to check.

Using the STABILITY and TRIGGERING LEVEL Controls

Triggered operation in all modes except AUTOMATIC and HF SYNC may require proper setting of the STABILITY and TRIGGERING LEVEL controls. The TRIGGERING LEVEL control has no effect in either AUTOMATIC or HF SYNC modes.

The STABILITY control has a PRESET position at the fully counterclockwise setting of the control. This position permits proper triggering in many applications without necessitating additional adjustment of the STABILITY control. If it becomes difficult or impossible for you to obtain proper triggering with the STABILITY control at PRESET, you must then adjust the control. This is done with the TRIGGERING LEVEL control fully counterclockwise. The STABILITY control is rotated clockwise from the PRESET position until a trace appears on the screen. The proper STABILITY setting for a triggered display is then obtained by turning the knob slowly counterclockwise until the trace just disappears.

The TRIGGERING LEVEL control should then be turned slowly toward the 0 position until a stable display appears on the screen. The TRIGGERING LEVEL control also determines the exact point on the triggering waveform where triggering of the sweep occurs. Turning the control clockwise causes the sweep to trigger at more negative points. If the displayed waveform is vertically centered under the graticule, setting the TRIGGERING LEVEL control at 0 will cause the sweep to start at approximately the mid-voltage point of the waveform.

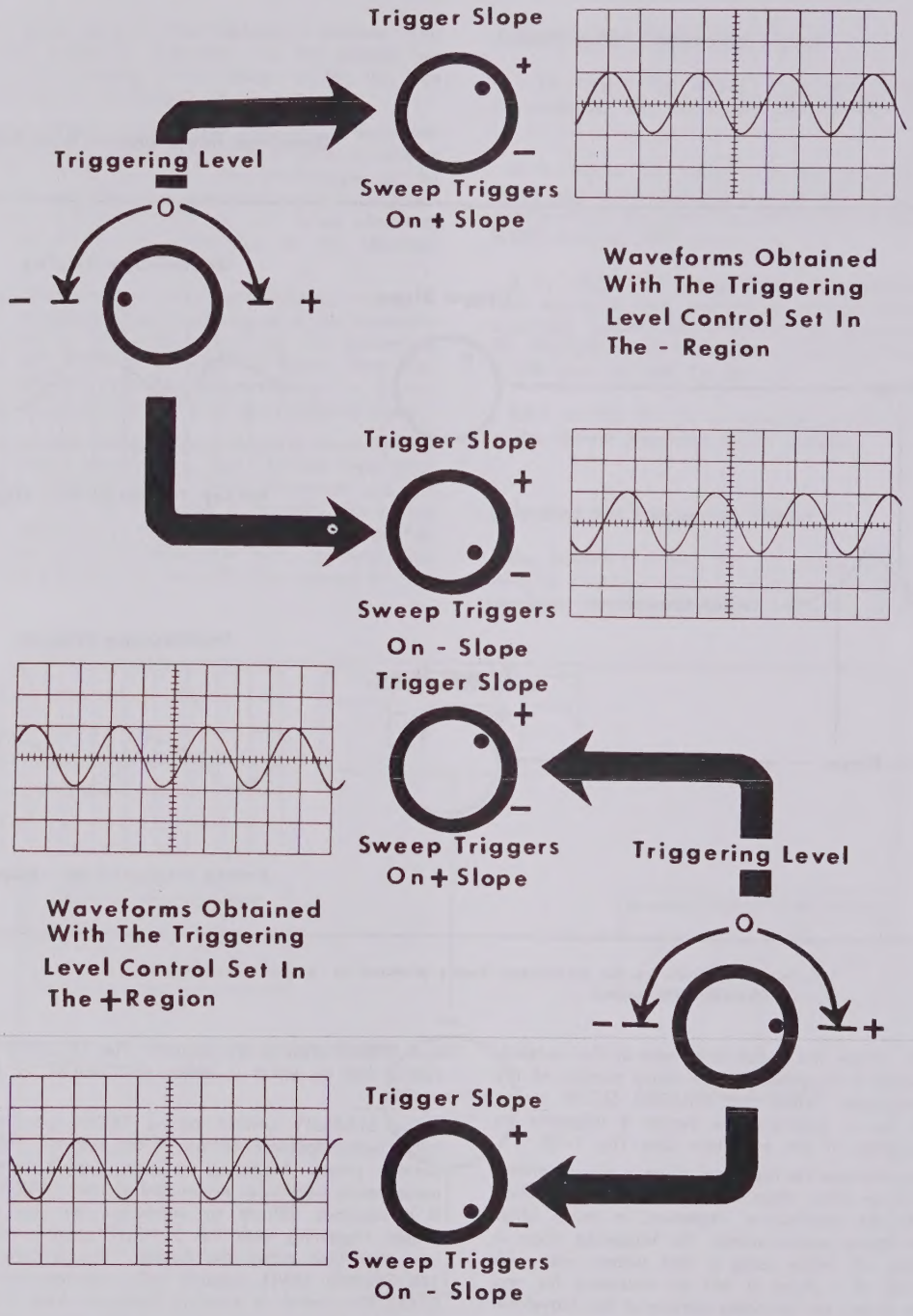


Fig. 2-11. Effects on the oscilloscope display produced by + and — settings of the TRIGGERING LEVEL control. When the TRIGGERING LEVEL control is set in the + region, the sweep is triggered on the upper portion of the input waveform; when it is set in the — region, the sweep is triggered on the lower portion of the input waveform. The TRIGGER SLOPE control determines whether the sweep is triggered on the rising portion or the falling portion of the input waveform.

Selecting the Triggering Mode

After selecting the triggering source and triggering slope, it is next necessary to select the triggering mode which will allow you to obtain the desired display. Five triggering modes are available. In the Type 543, they are DC, AC SLOW, AC FAST, AUTOMATIC and HIGH FREQUENCY SYNC. In the Type 543A, they are DC, AC, AC LOW FREQUENCY REJECT, AUTOMATIC and HIGH FREQUENCY SYNC.

Each of the triggering modes is designed to provide stable triggering from a certain type of waveform. For most applications however, several of the triggering modes will work equally well. For applications of this type, the triggering mode used is purely a matter of choice. The primary thing to consider in choosing the triggering mode is whether or not it allows you to obtain the display you want.

To determine the best mode of operation for a particular application, it is usually best to try each triggering mode in the application. The Automatic mode should be tried first since this triggering mode provides stable triggering in most applications without the necessity of setting the STABILITY or TRIGGERING LEVEL controls. If the Automatic mode does not provide the desired display, it will then be necessary for you to try one or more of the triggering modes.

AUTOMATIC Triggering Mode

The AUTOMATIC mode is most frequently used because of its ease of operation. This mode is useful in obtaining stable triggering from waveforms with frequencies of from approximately 60 cycles to 2 megacycles. The principal advantage of this type of operation is that it is not necessary to adjust either the STABILITY or TRIGGERING LEVEL controls to obtain a stable display. This permits you to observe a large number of waveforms with different shapes and amplitudes without adjusting any of the triggering controls. In the absence of a triggering signal, the sweep continues to run to provide a convenient reference trace on the oscilloscope screen.

The AUTOMATIC triggering mode is selected by placing the TRIGGERING MODE switch in the AUTO. position. The triggering source and slope is then selected and the input signal is applied to the oscilloscope. No other control adjustments are required. Since the TRIGGERING LEVEL control has no effect on the display when automatic triggering is used, it is impossible to select the point on the triggering waveform where the sweep is triggered. Each sweep is instead triggered at the average voltage point of the waveform.

DC Triggering Mode

In the DC mode, the sweep can be triggered from periodic signals in the range from dc to 5 mc. This mode is especially useful with trigger signals that change slowly, and is also useful when it is desired to trigger at a certain point (voltage level) on a waveform with respect to ground.

Another application of the DC triggering mode is to attain a stable display of a random-pulse train. The average voltage of this type of signal is dependent upon the time duration and amplitude of each pulse and the time lapse between successive pulses. Since there are variable quantities in a random-pulse train, the average voltage will also vary. This is likely to cause unstable triggering in the AC modes. In the DC mode, however, the circuits are sensitive to the instantaneous voltage only. Changes in the average voltage do not alter the operation of the circuits. As a result, the TRIGGERING LEVEL control can be adjusted to initiate a sweep whenever a pulse reaches the desired voltage.

AC SLOW (AC) Triggering Mode

Selection of the AC SLOW (AC) triggering mode is made by placing the TRIGGERING MODE switch in the AC SLOW (AC) position. This mode provides useful triggering in the frequency range of approximately 15 cycles to 5 mc. These frequency limits vary slightly depending upon the shape and amplitude of the triggering waveform. In the AC SLOW or AC mode, triggering is unaffected by the dc components of the triggering signal or by the vertical positioning of the trace. The triggering level can be selected to provide the desired display using the STABILITY and TRIGGERING LEVEL controls. These two controls are set as described for the DC mode.

AC FAST (AC LF REJECT) Mode

The AC FAST (AC Low Frequency Reject) triggering mode is used when the TRIGGERING MODE switch is in the AC FAST (AC LF Reject) position. This mode is similar to the slower AC mode except that low-frequency waveforms are rejected by the triggering circuit. This triggering mode works well with high-frequency waveforms, but it may be difficult to obtain stable triggering with frequencies below approximately 1000 cycles.

Occasionally you may be required to obtain stable triggering from a fairly high-frequency waveform that is mixed with a great deal of low frequency noise or line frequency pickup. In such cases the additional noise and pickup can make it very difficult to obtain a stable display. If this occurs, you can select the AC FAST (AC LF REJECT) triggering mode, thereby eliminating the effects of the low frequency noise and pickup. The low frequencies are blocked from the triggering circuit while the high frequency triggering waveform is passed to produce the stable triggering that you need. In all other respects, the two AC triggering modes are identical.

HF SYNC Triggering Mode

The High Frequency Synchronization Mode permits stable displays of waveforms with frequencies higher than approximately 5 mc. Stability of the display is adjusted with the STABILITY control. The TRIGGERING LEVEL control is not used. To use the High Frequency Synchronization Mode, place the TRIGGERING MODE switch in the HF SYNC position. Turn the STABILITY control clockwise until a trace appears. Continue to adjust the STABILITY control until a stable display is obtained.

Although the synchronization signal source is selected with the TRIGGER SLOPE control, the slope cannot be selected. Also you cannot use the PRESET position of the STABILITY control in this mode.

Free-Running Sweep Operation

In the usual oscilloscope application, the sweep is triggered or synchronized by the input waveform. However, in some applications it may be more desirable to reverse the process and initiate the input waveform through use of a periodically recurrent waveform from the oscilloscope. In this type of application the sweep is caused to free-run and an output from either the + GATE OUT or SAW-TOOTH OUT connectors is used to trigger or synchronize the input waveform. (See Fig. 2-12).

The sweep can be made to free run with any setting of the TRIGGERING MODE switch by turning the STABILITY control fully clockwise. In all positions of the TRIGGERING MODE switch except AUTO. the number of sweeps per second is determined by the setting of the TIME/CM controls. In the AUTO. position, the sweep repetition rate remains at approximately 50 sweeps per second regardless of the setting of the TIME/CM control.

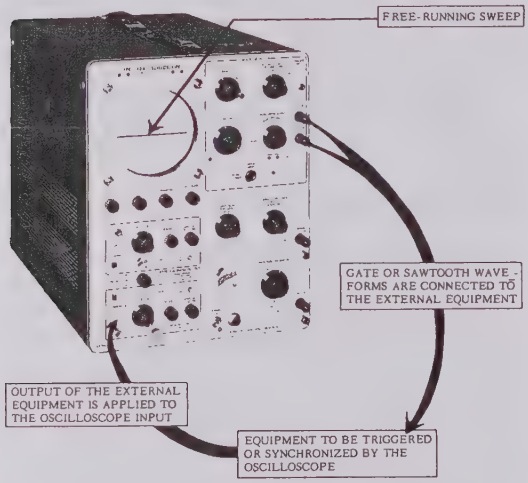

FREE-RUNNING SWEEP
GATE OR SAWTOOTH WAVE-FORMS ARE CONNECTED TO THE EXTERNAL EQUIPMENT
OUTPUT OF THE EXTERNAL EQUIPMENT IS APPLIED TO THE OSCILLOSCOPE INPUT
EQUIPMENT TO BE TRIGGERED OR SYNCHRONIZED BY THE OSCILLOSCOPE

Fig. 2-12. Using the Gate or Sawtooth output waveforms to synchronize or trigger external equipment.

In addition to providing the means for controlling an applied waveform, a free-running sweep also provides a convenient reference trace on the oscilloscope screen without requiring an input signal. This trace can then be used to position the sweep or to establish a voltage reference line.

Sweep Magnification

To magnify a particular part of a display, position that portion of the display with the HORIZONTAL POSITION controls so that it appears near the center of the graticule. Then turn the HORIZONTAL DISPLAY control to the desired SWEEP MAGNIFIED position. That part of the display which formerly occupied the middle section of the graticule will now be expanded horizontally by the selected magnification factor. The apparent time calibration of the X (sweep) axis will now be equal to the setting of the TIME/CM control divided by the magnification factor.

External Horizontal Deflection

In some instances it may be necessary to deflect the beam horizontally by means of an externally derived waveform, rather than by means of the internal sweep. To accomplish this, set the HORIZONTAL DISPLAY switch to EXT. and connect the source of the waveform to the EXTERNAL HORIZ. IN connector. Set the EXTERNAL HORI-

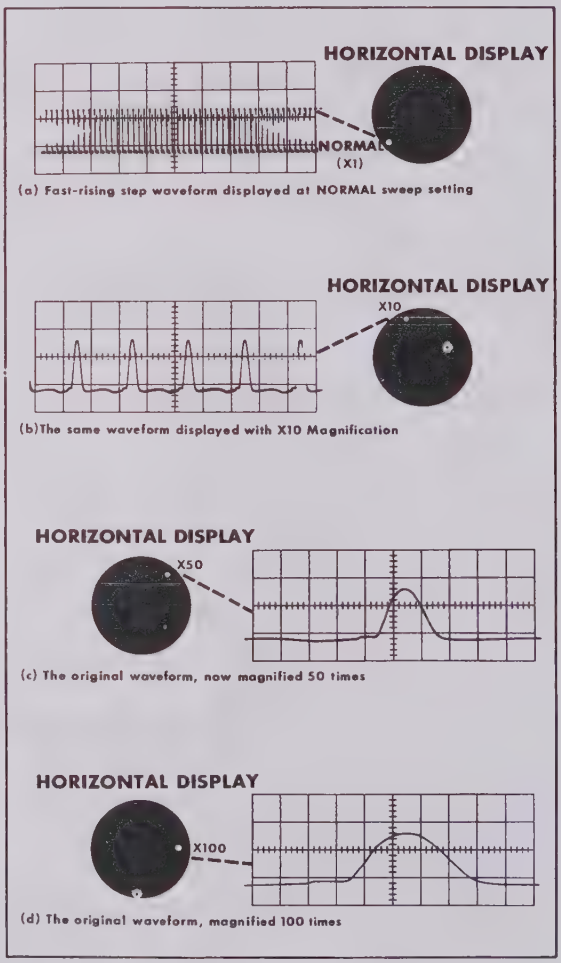


Fig. 2-13. Effects of the sweep magnifier control on the same waveform at various Magnified settings.

ZONTAL controls (VOLTS/CM and VARIABLE) for the desired amount of horizontal deflection. Three ranges of fixed attenuation (of the external sweep signal) are provided, with a variable control to interpolate between ranges.

Output Waveforms

For certain external applications, the sawtooth sweep waveform is available at the SAWTOOTH OUT connector on the front panel. This positive waveform starts at about ground and rises linearly to a peak amplitude of about 150 volts.

The start and duration of the rising part of the sawtooth coincides with the start and duration of the horizontal sweep on the crt. The rate at which the sawtooth rises is determined by the setting of the TIME/CM control.

A positive rectangular waveform is available at the + GATE OUT connector. This waveform starts at ground and rises to about 20 volts. The starting time and duration of each pulse coincides with the starting time and duration of the positive-going part of the sawtooth available at the SAWTOOTH OUT connector.

Single Sweep

The Type 543/543A contains a single-sweep (sweep lockout) feature which permits a waveform to be displayed for one horizontal sweep only. Subsequent sweeps and waveform displays are locked out until the circuit is rearmed. This feature is particularly useful for photographing random or nonrepetitive signals.

To use the single-sweep feature, set the instrument for normal manually-triggered operation. Click the spring-loaded NORMAL SWEEP-SINGLE SWEEP switch to the RESET position. Let it return to the SINGLE SWEEP position. The READY lamp will light. The next trigger pulse will produce a single horizontal sweep. Subsequent triggers will have no effect on the circuit until the READY lamp is lighted with the RESET switch.

AUXILIARY FUNCTIONS

Calibrator

The calibrator provides a convenient source of square waves of known amplitude at a frequency of approximately 1 kc. The square-waves are used primarily to adjust probes and to verify the calibration of the vertical deflection system of the oscilloscope and plug-in unit.

Calibrator square-waves are adjustable from .2 millivolts peak to peak, to 100 volts peak to peak, in 18 steps. Calibrator output amplitude is controlled on the Type 543 by two SQUARE-WAVE CALIBRATOR switches on the front panel. The large black knob sets nine ranges of output in increments of from .2 to 100. The small concentric red knob, labeled VOLTS, MILLIVOLTS, OFF, determines the proper output in volts or millivolts. On the Type 543A, a single AMPLITUDE CALIBRATOR knob controls the full range of 18 outputs, ranging in steps from .2 millivolts to 100 volts.

The peak to peak calibrator voltage is within 3 percent of the CALIBRATOR switch setting when the output is connected to a high impedance load.

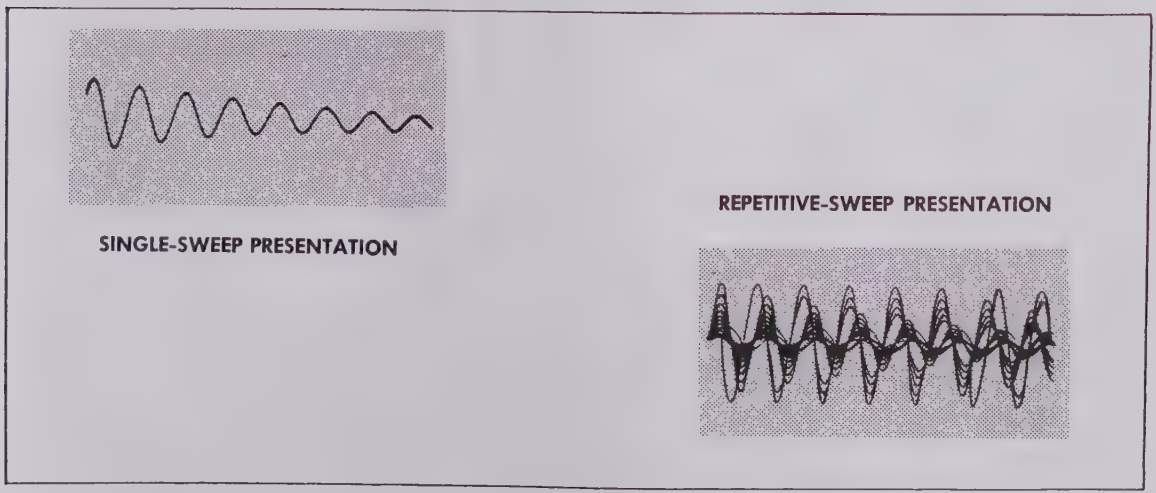


Fig. 2-14. Comparison of single sweep and repetitive sweep presentation of a damped sine wave. In the repetitive sweep presentation, it is difficult to determine what is being presented. However, in the single sweep presentation the damped sine wave can be clearly seen.

Dual Trace Displays

The Type CA Plug-In unit allows you to obtain two separate traces on the face of the crt. This permits you to display two functions simultaneously. Detailed instructions for operating the Type CA Unit in conjunction with the Type 543/543A Oscilloscope are contained in the Instruction Manual for the Type CA Unit.

When you are using the Type CA Unit in the chopped mode to obtain a dual-trace presentation, switching transients will be displayed on the screen. You can eliminate these switching transients by placing the CRT CATHODE SELECTOR switch on the rear of the instrument in the DUAL TRACE CHOPPED BLANKING position.

Intensity Modulation

The crt display on the Type 543/543A Oscilloscope can be intensity modulated by an external signal to display additional information. This is done by disconnecting the grounding bar from the EXTERNAL CRT CATHODE connector at the rear of the instrument and connecting the external signal to this terminal. The CRT CATHODE SELECTOR switch must be in the EXTERNAL CRT CATHODE position.

When you wish to make very accurate time measurements from the crt display, you can intensity modulate the beam with time markers presented on the screen. A positive signal of approximately 25 volts is required to cut off the beam from normal intensity.

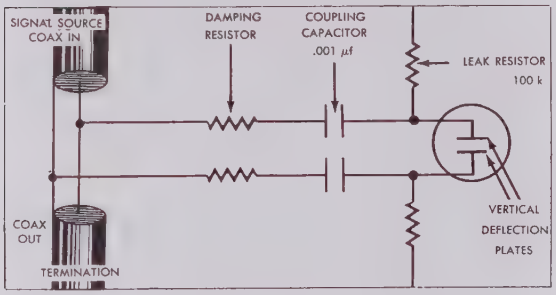


Fig. 2-15. Connecting to the crt deflection plates by AC coupling.

Direct Connection to CRT Deflection Plates

The vertical deflection plate pins are located on the side of the crt neck. The horizontal deflection plate pins are located on the top. In some applications, it is advantageous to connect a signal directly to either one, or both sets of these deflection plate pins — bypassing the internal oscilloscope amplifiers. Maintain the average dc voltage on the deflection plates between +275 and +300 volts. If the voltage is not within this range, the crt displayed becomes defocused.

For dc coupling, it is necessary to supply positioning voltages from the signal source. These voltages should fall within the +275 and +300 volt range. When dc coupling the signal to the deflection plates, you should tape the ends of the wires you have removed from the crt pins. This prevents shorting to the chassis and damage to the amplifier. The external signal source is then connected to the crt pins.

In many applications, it is advantageous to use ac coupling. This is necessary for those signals which cannot be made to have the right dc voltage. Positioning is controlled through the vertical amplifier with its normal positioning controls.

The usual direct deflection application is to make use of the ultimate rise-time capability of the crt in the oscilloscope. This requires careful connection to the deflection plates from coaxial cables through damping resistors, and physically small coupling capacitors. These leads should be set close to the crt pins, should be short, and should be rigid. Tie down the coax so that a pull on the coax will not break the crt.

Referring to Fig. 2-15, connect one damping resistor to the coax center conductor. Connect the other damping resistor to the coax outer conductor. The size of the damping resistor will depend upon the coaxial line impedance, the lead lengths, and the coupling capacitor type. The best value is found by passing a fast-rise signal through the coax and adjusting the resistance until the display is just short of overshoot. A good starting value is 68 Ω for a 52-Ω coaxial cable. No damping resistors are needed for cables with impedances above approximately 200 Ω.

In order to realize the desired amount of deflection sensitivity in the Type T543 Cathode Ray Tube, the deflection plates have been placed as close as possible to the path of the electron beam. As a result, a small amount of current will flow in the deflection plate circuits. This current flow varies nonlinearly with the beam position, increasing rapidly in that plate toward which the beam is positioned. In the Type 543/543A oscilloscope, the effects of these currents are negligible. However, if the resistance is increased, these currents can cause objectionable voltage drops. For values of resistance greater than 110 K for the leak resistor, you may experience some difficulty from the current collected on the deflection plates. Some defocusing or distortion may be evident. These effects are most noticeable when the display is positioned close to the limits of the crt graticule.

The low frequency response required will determine the size of the coupling capacitor needed. The formula for the size of the coupling capacitor is $C = 1/(2\pi RF)$, where R is the leak resistor, and F is the desired low-frequency cutoff. For example, to find the coupling capacitor needed when the low frequency cutoff is 1600 cps and the leak resistor is 100 K, take the reciprocal of $2\pi RF$. The coupling capacitor is .001 μf.

The coupling capacitor should be spaced about $\frac{1}{4}$" to $\frac{3}{8}$" from the damping resistors, and should be of the ceramic disc type, or equivalent, to preserve the fast-rise capability of the Type T543 crt.

To simplify making the direct connection to the crt vertical deflection plates, you can order a plastic plate and mounting bracket from Tektronix Inc. The mounting

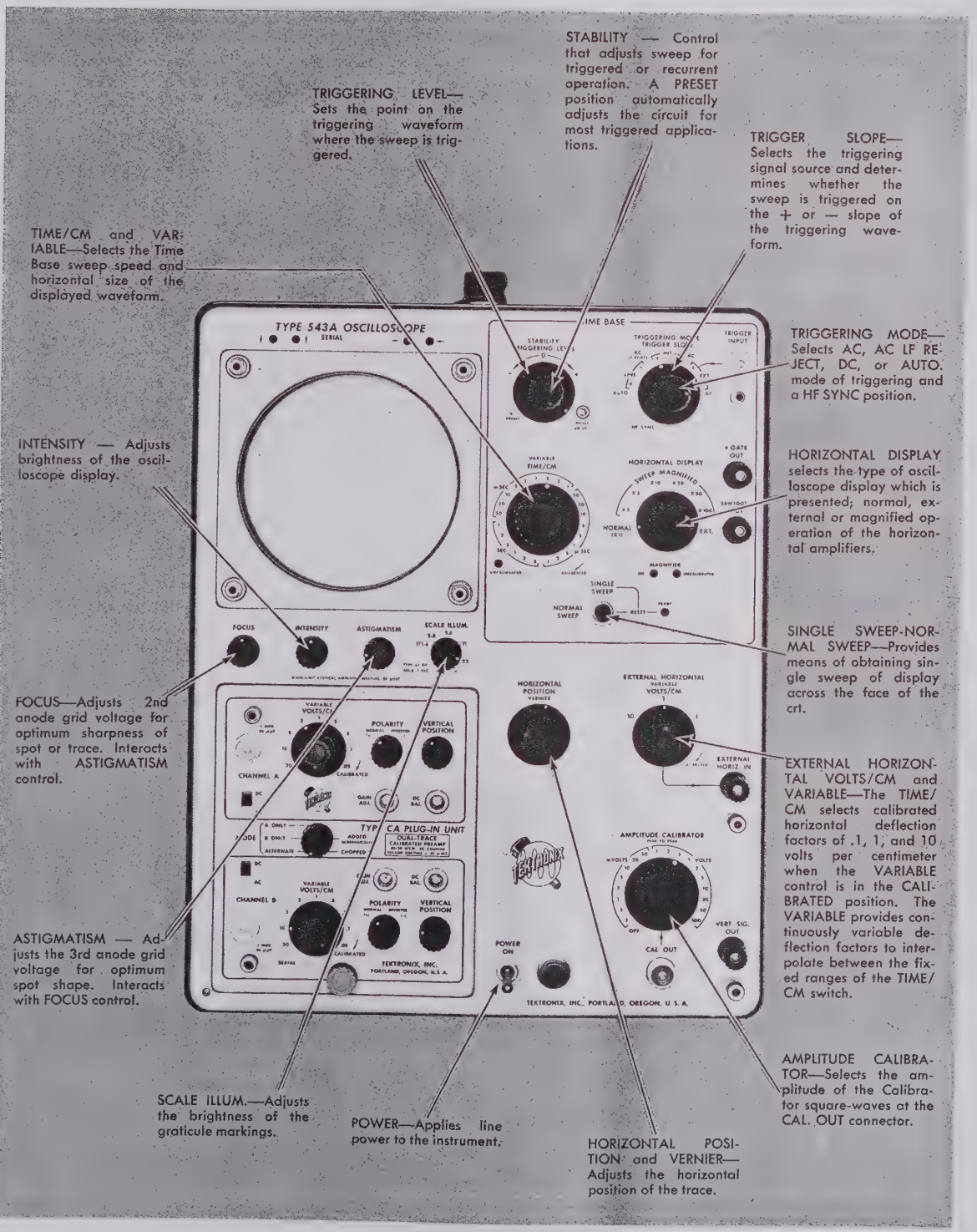
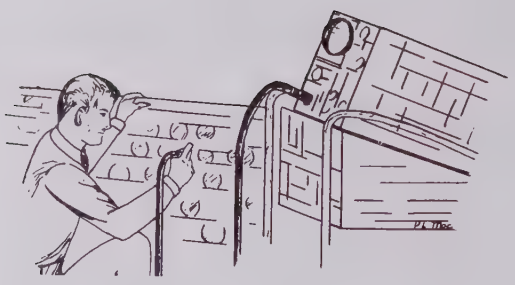

STABILITY — Control that adjusts sweep for triggered or recurrent operation. A PRESET position automatically adjusts the circuit for most triggered applications.
TRIGGERING LEVEL—Sets the point on the triggering waveform where the sweep is triggered.
TRIGGER SLOPE—Selects the triggering signal source and determines whether the sweep is triggered on the + or — slope of the triggering waveform.
TIME/CM and VARIABLE—Selects the Time Base sweep speed and horizontal size of the displayed waveform.
TRIGGERING MODE—Selects AC, AC LF REJECT, DC, or AUTO. mode of triggering and a HF SYNC position.
INTENSITY — Adjusts brightness of the oscilloscope display.
HORIZONTAL DISPLAY selects the type of oscilloscope display which is presented; normal, external or magnified operation of the horizontal amplifiers.
SINGLE SWEEP-NORMAL SWEEP—Provides means of obtaining single sweep of display across the face of the crt.
FOCUS—Adjusts 2nd anode grid voltage for optimum sharpness of spot or trace. Interacts with ASTIGMATISM control.
EXTERNAL HORIZONTAL VOLTS/CM and VARIABLE—The TIME/CM selects calibrated horizontal deflection factors of .1, 1, and 10 volts per centimeter when the VARIABLE control is in the CALIBRATED position. The VARIABLE provides continuously variable deflection factors to interpolate between the fixed ranges of the TIME/CM switch.
ASTIGMATISM — Adjusts the 3rd anode grid voltage for optimum spot shape. Interacts with FOCUS control.
AMPLITUDE CALIBRATOR—Selects the amplitude of the Calibrator square-waves at the CAL. OUT connector.
SCALE ILLUM.—Adjusts the brightness of the graticule markings.
POWER—Applies line power to the instrument.
HORIZONTAL POSITION and VERNIER—Adjusts the horizontal position of the trace.
TYPE 543A OSCILLOSCOPE
TIME BASE
TYPE CA PLUG-IN UNIT
TEKTRONIX, INC. PORTLAND, OREGON, U.S.A.

Fig. 2-16. Functions of the Type 543/543A Oscilloscope front panel controls.

bracket is designed to clamp around the neck of the crt shield, adjacent to the deflection plate connections. When mounted correctly, the plate will be accessible through the crt deflection plate access hole in the left side panel. The bracket and plate may be ordered with or without the necessary parts for vertical positioning voltages. Specify part number 013-008 for the blank unit without parts, or part number 013-007 for the wired unit. Holes can be drilled in the plastic plate for mounting coaxial cable and other connectors.



SECTION 3

APPLICATIONS

Voltage Measurements

The Type 543/543A Oscilloscope can be used to measure the voltage of the input waveform by using the calibrated vertical-deflection factors of the instrument and associated plug-in unit. The method used for all voltage measurements is basically the same although the actual techniques vary somewhat depending on the type of voltage measurements required. Essentially there are two types of voltage measurements: ac-component voltage measurements and instantaneous voltage measurements with respect to some reference potential. Many waveforms contain both ac and dc voltage components. It is often necessary to measure one or both of these components.

When making voltage measurements, you should display the waveform over as large a vertical portion of the screen as possible for maximum accuracy. Also, it is important that you do not include the width of the trace in your measurements. You should consistently make all measurements from one side of the trace. If the bottom side of the trace is used for one reading, it should be used for all succeeding readings. The VARIABLE VOLTS/CM control must be in the CALIBRATED position.

AC Component Voltage Measurements

To measure the ac component of a waveform, the plug-in unit input selector switch should usually be set to one of the AC positions. In these positions only the ac components of the input waveform are displayed on the oscilloscope screen. However, when the ac component of the input waveform is of very low frequency, it is necessary for you to make voltage measurements with the input selector switch in one of the DC positions to prevent errors.

To make a peak-to-peak voltage measurement on the ac component of a waveform, perform the following steps (see Figure 3-1);

1. With the aid of the graticule, measure the vertical distance in centimeters from the positive peak to the negative peak.

2. Multiply the vertical distance measured by the setting of the plug-in unit VOLTS/CM control to obtain the indicated voltage.

3. Multiply the indicated voltage by the attenuation factor of the probe used to obtain the actual peak-to-peak voltage.

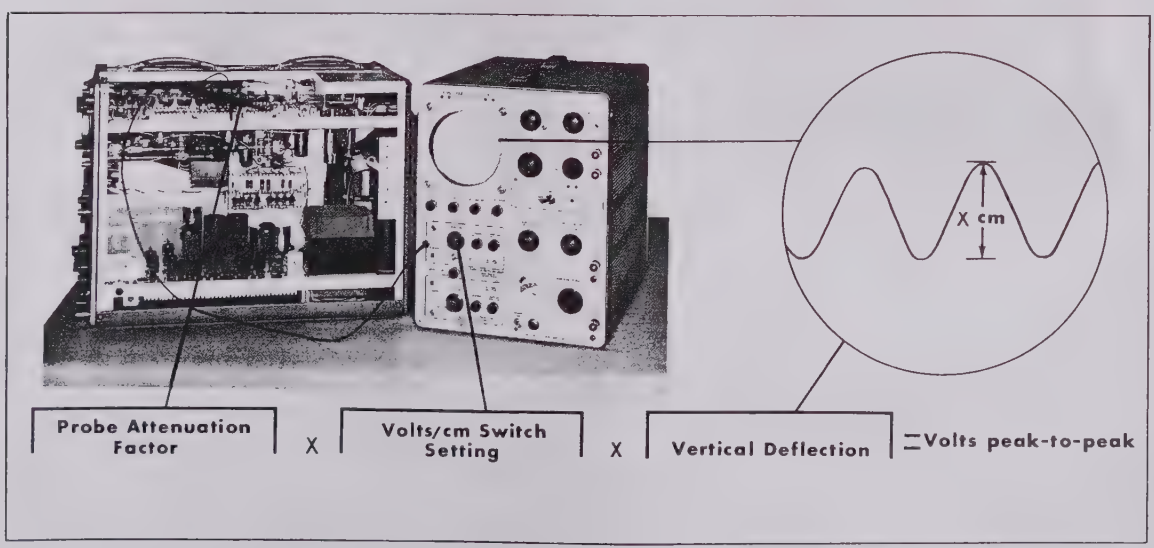


Fig. 3-1. Measuring the peak-to-peak ac component voltage of an applied waveform.

As an example of the method, assume that using a 10X probe and a deflection factor of 1 volt per centimeter, you measure a vertical distance between peaks of 4 centimeters. In this case then, 4 centimeters multiplied by 1 volt per centimeter gives you an indicated voltage of 4 volts peak-to-peak. The indicated voltage multiplied by the probe's attenuation factor of 10 then gives you the true peak-to-peak amplitude of 40 volts.

When sinusoidal waveforms are measured, the peak-to-peak voltage obtained can be converted to peak, rms, or average voltage through use of standard conversion factors.

Instantaneous Voltage Measurements

The method used to measure instantaneous voltage is virtually identical to the method described previously for the measurements of the ac components of a waveform. However, for instantaneous voltage measurements the plug-in unit input selector switch must be placed in one of the DC positions. Also since instantaneous voltages are measured with respect to some potential (usually ground), a reference line must be established on the oscilloscope screen which corresponds to that potential. If, for example, voltage measurements are to be made with respect to +100 volts, the reference line would correspond to +100 volts. In the following procedure the method is given for establishing this reference line as ground since measurements with respect to ground are by far the most common type. The same general method may be used to measure voltage with respect to any other potential, however, so long as that potential is used to establish the reference line.

To obtain an instantaneous voltage measurement with respect to ground perform the following steps (see Figure 3-2):

1. To establish the voltage reference line, touch the probe tip to an oscilloscope ground terminal (or if the reference line is to represent a voltage other than ground, to a source of that voltage) and adjust the oscilloscope controls to obtain a free-running sweep. Vertically position the trace to a convenient point on the oscilloscope screen. This point will depend on the polarity and amplitude of the input signal, but should always be chosen so that the trace lies along one of the major divisions of the graticule. The graticule division corresponding to the position of the trace is the voltage reference line and all voltage measurements must be made with respect to this line. (Do not adjust the vertical positioning control after the reference line has been established.)

2. Remove the probe tip from ground and connect it to the signal source. Adjust the triggering controls for a stable display.

3. Using the graticule measure the vertical distance in centimeters from the desired point on the waveform to the voltage reference line.

4. Multiply the setting of the VOLTS/CM control by the distance measured to obtain the indicated voltage.

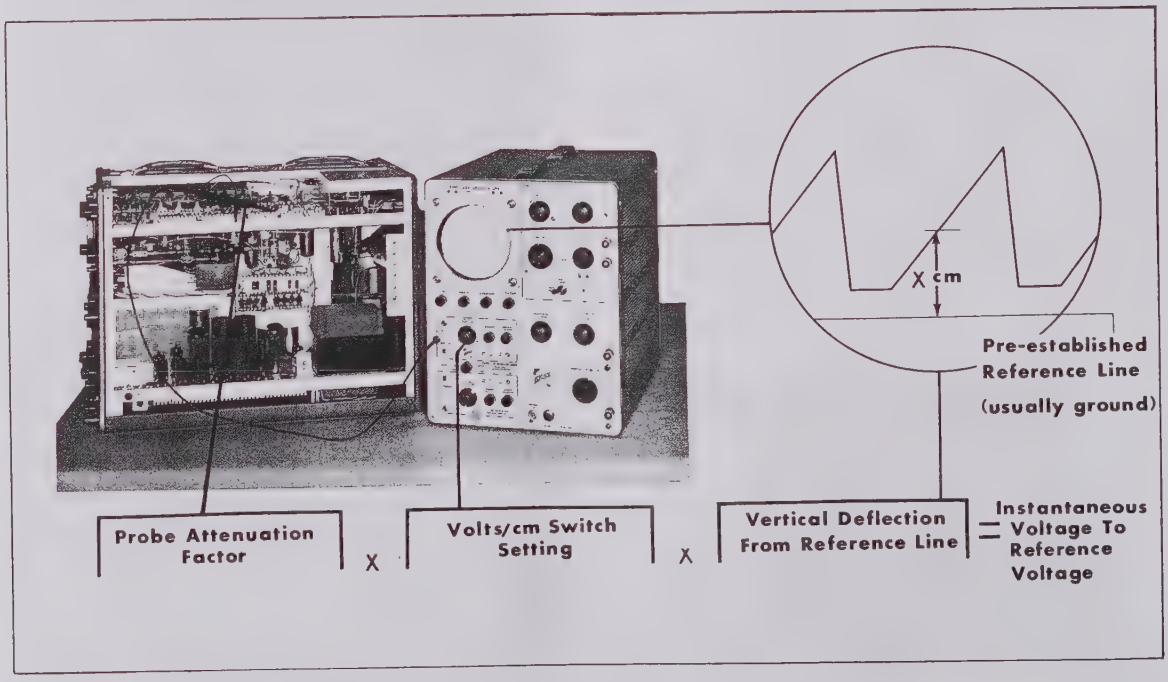


Fig. 3-2. Measuring the instantaneous voltage with respect to ground (or some other reference voltage.)

5. Multiply the indicated voltage by the attenuation factor of the probe you are using to obtain the actual voltage with respect to ground (or other reference voltage).

As an example of this method, assume that you are using a 10X probe and deflection factor of .2 volts per centimeter. After setting the voltage reference line at the second from the bottom division of the graticule, you measure a distance of 3 centimeters to a point you wish to check. In this case then, 3 centimeters multiplied by .2 volts per centimeter gives you an indicated .6 volts. Since the voltage point is above the voltage reference line, the polarity is indicated to be positive. The indicated voltage multiplied by the probe's attenuation factor of 10 then gives you the actual voltage of positive 6 volts.

Time Measurements

The calibrated sweeps of the 543/543A Oscilloscopes cause any horizontal distance on the screen to represent a definite known interval of time. Using this feature you can accurately measure the time lapse between two events displayed on the oscilloscope screen. This is done by the following method.

1. Using the graticule, measure the horizontal distance between the two displayed events whose time interval you wish to find.

2. Multiply the distance measured by the setting of the TIME/CM control to obtain the apparent time interval. (The VARIABLE TIME/CM control must be in the CALIBRATED position).

3. Divide the apparent time interval by the sweep magnification, to obtain the actual time interval.

For example, assume that the TIME/CM switch setting is 1 MILLISEC, the SWEEP MAGNIFIED switch is on X5, and that you measure a horizontal distance of 5 centimeters between events. In this example then, 5 centimeters multiplied by 1 millisecond per centimeter gives you an apparent time interval of 1 millisecond.

Frequency Measurements

Using the methods described in the previous section, you can measure the period (time required for one cycle) of a recurrent waveform. The frequency of the waveform can then easily be calculated since frequency is the reciprocal of the period. For example, if the period of a recurrent waveform is accurately measured and found to be 0.2 microseconds, the frequency is the reciprocal of 0.2 microseconds, or 5 mc.

At any given oscilloscope sweep speed, the number of cycles of the input waveform that is displayed on 10 centimeters of the screen is dependent on the frequency of the input waveform. Frequencies can usually be measured faster by the following method than by the one given in the last paragraph.

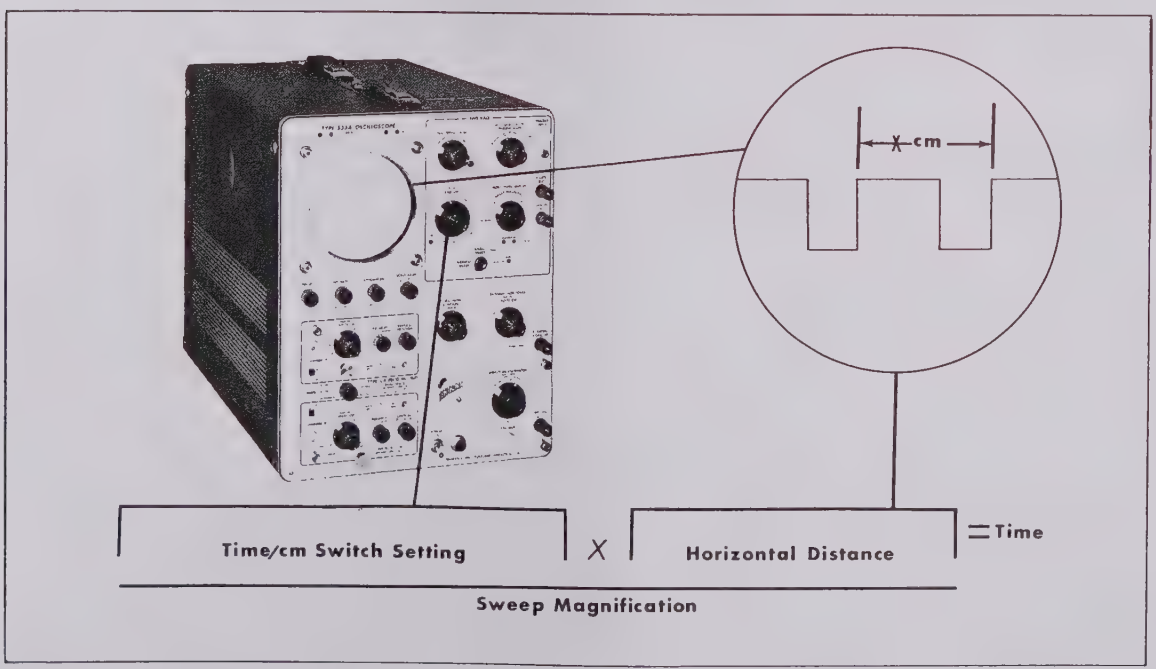


Fig. 3-3. Measuring time interval between events displayed on the oscilloscope screen.

If you divide the cycles per unit of length by the time required for the input waveform to sweep this unit of length, you get the frequency. The total number of cycles are found for 10 cm for greater accuracy. Since the TIME/CM switch gives time for 1 cm, multiply this setting by 10 to have the time required for 10 cm. (See Figure 3-4).

To obtain the frequency of a repetitive input signal, perform the following steps.

1. Adjust the TIME/CM control to display several cycles of the input waveform. Insure that the VARIABLE TIME/CM control is in the CALIBRATED position.

2. Count the number of cycles of the waveform shown on the 10 centimeters of the graticule.

3. Divide this number by 10 times the TIME/CM switch setting. This gives you the frequency of the input waveform.

For example, assume that when you are using a sweep speed of 50 milliseconds per centimeter, you count 7.2 cycles in 10 centimeters. The frequency is 7.2 cycles divided by 50 milliseconds times 10, or 500 milliseconds. 500 milliseconds are 500 x .001 seconds, or .5 seconds. 7.2 cycles per ½ second gives you 14.4 cycles per second.

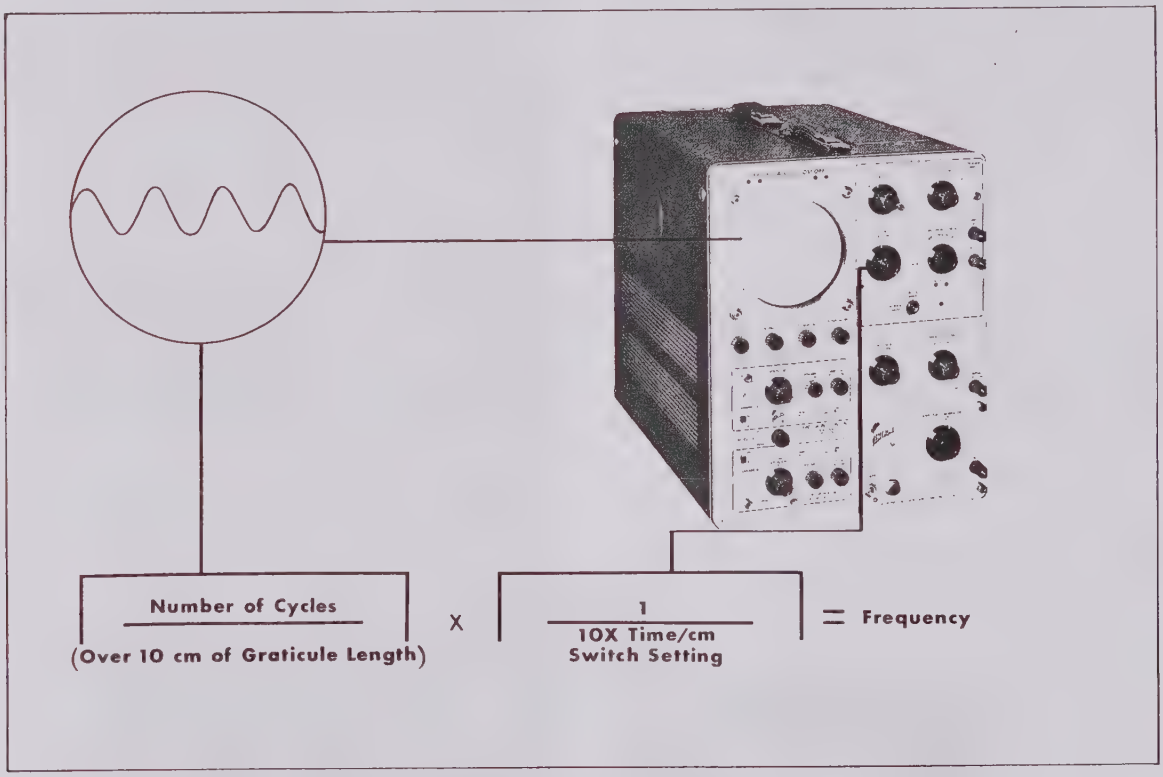
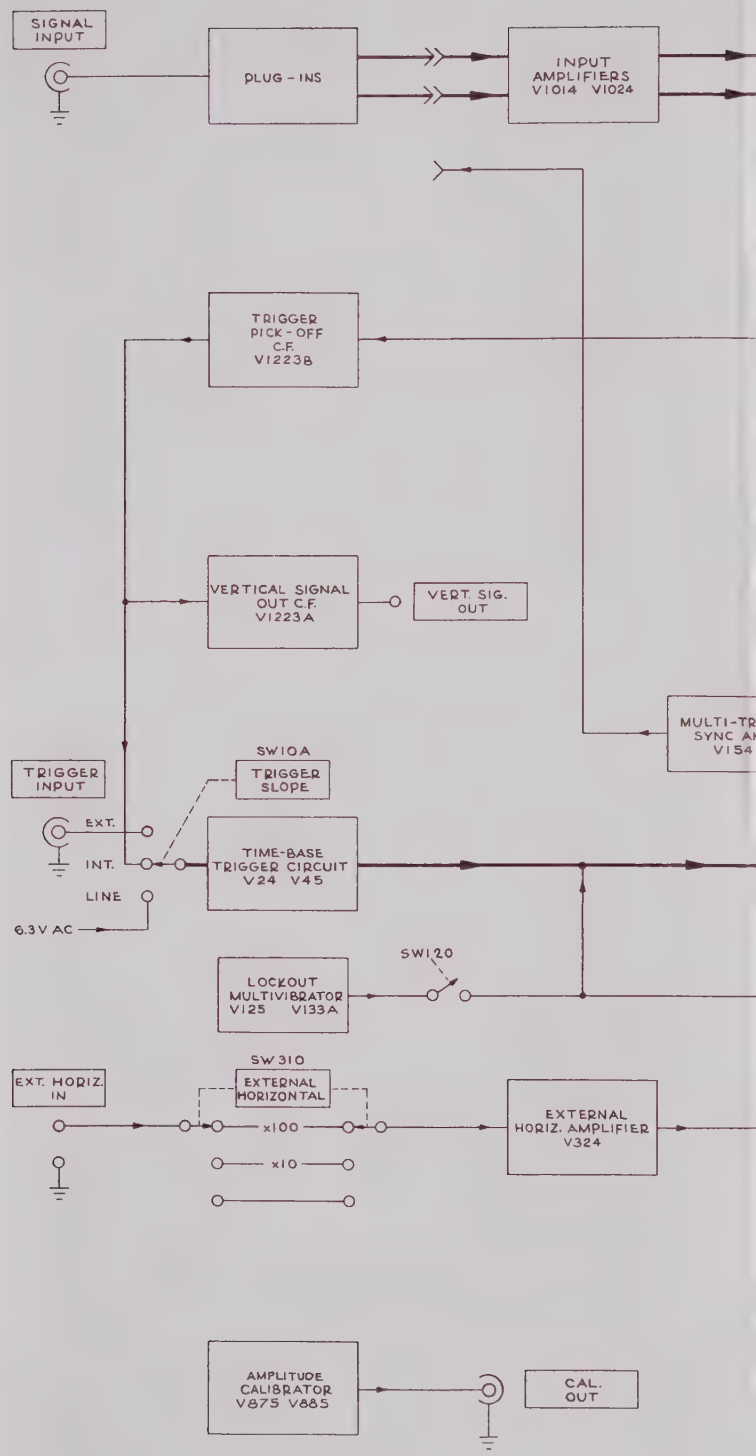
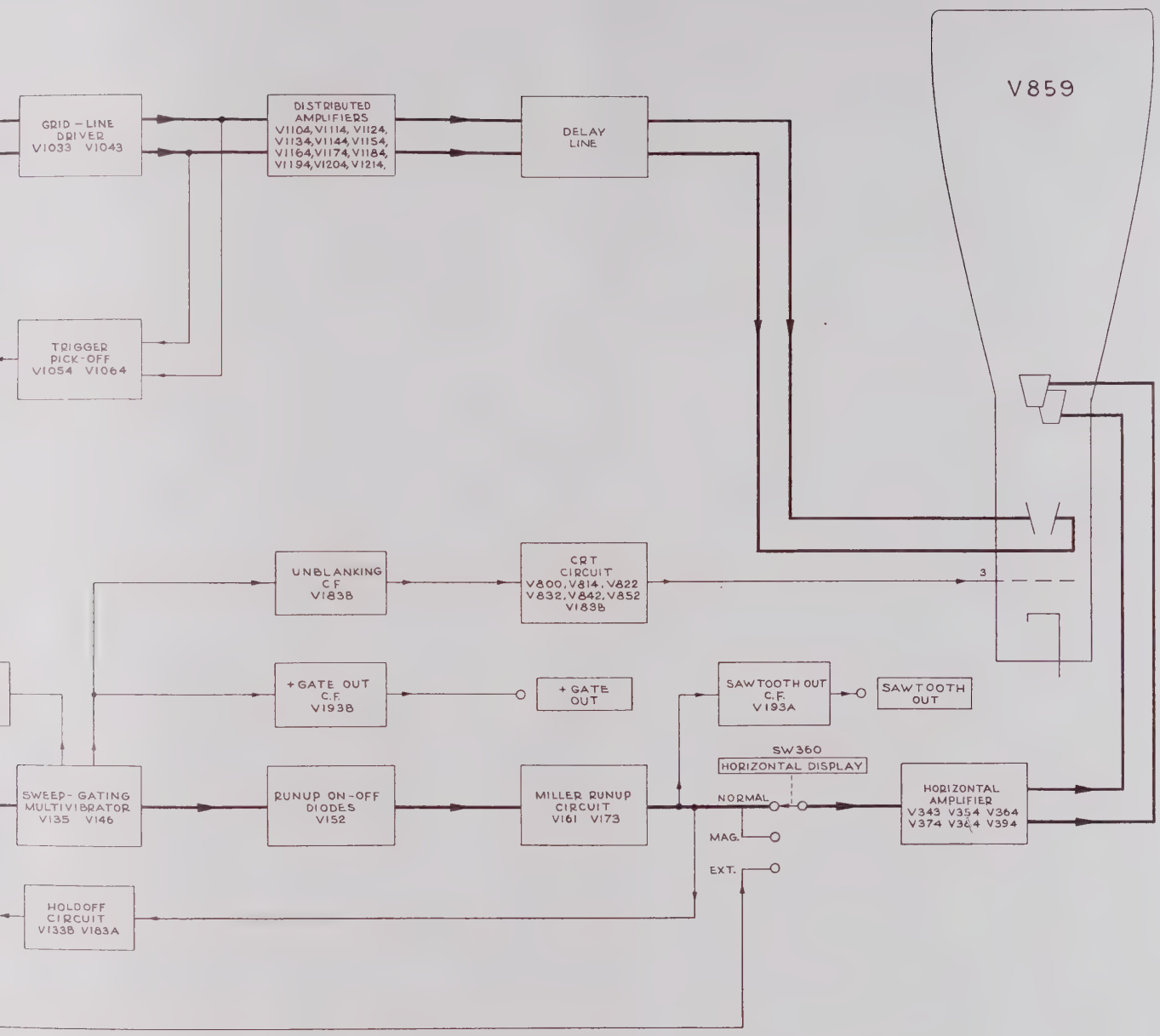


Fig. 3-4. Measuring the frequency of a repetitive input signal.



TYPE 543/543A OSCILLOSCOPE



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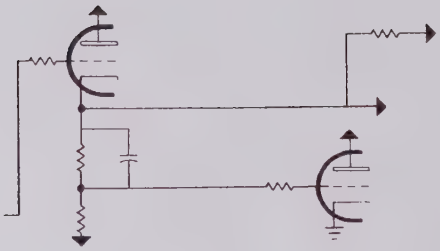
AA,

BLOCK DIAGRAM



SECTION 4

CIRCUIT DESCRIPTION

VERTICAL DEFLECTION SYSTEM

General

The dc-coupled, push-pull, main Vertical Amplifier provides the necessary gain to drive the Delay Line and the vertical deflection plates of the crt. The main units of the Vertical Amplifier are the Input Amplifier stage V1014 and V1024, the Cathode-Follower Driver stages V1033 and V1043, and the 6-stage Distributed Amplifier output stage. Other circuits of importance are the Trigger Pickoff Amplifier V1054 and V1064, the Trigger Pickoff C.F. V1223B, the Vert. Sig. Out C.F. V1223A and the Indicator Amplifiers and Lamps, V1084A and B1083, and V1084B and B1087, respectively.

Input Circuit

The signal input from the plug-in unit is coupled through terminals 1 and 3 of the interconnecting plug to the grids of the Input Amplifier stage. R1027 varies the cathode degeneration, and thus sets the gain of the stage to agree with the Preamplifier's front-panel calibrations when the VARIABLE knob is in the CALIBRATED position.

The Input Amplifier is coupled to the Distributed Amplifier by the cathode followers V1033 and V1043. The cathode followers isolate the Distributed Amplifiers from the Input Amplifier, and provide the necessary low-impedance drive for the Distributed Amplifier's grid line.

High-frequency compensation for the Input Amplifier is provided by the variable peaking coils L1014 and L1024. Variable inductors L1036 and L1046 provide additional peaking at the very high frequencies.

Output Stage

The output stage is a 6-section Distributed Amplifier. The tapped inductors in the transmission line, between each grid and between each plate, isolate each section from the capacitance of the adjacent sections.

The input signal for each tube is obtained from the grid line, which is driven by the cathode followers V1033 and V1043. The amplified signal at each plate, fed to the plate line, becomes an integral part of the wave traveling down the line toward the deflection plates.

The vertical signal is delayed 0.2 microsecond between the input to the grid line and the vertical deflection plates. This delay insures that the very "front" of fast vertical signals can be observed. About 0.015 microsecond of the total delay time occurs in the Distributed Amplifier; the remaining 0.185 microsecond occurs in the Delay Line.

The tapped inductors between each section of the Distributed Amplifier provide about 0.003 microsecond of delay. By making the delay time in the grid and plate lines equal, the signal arriving at each plate, through the electron stream of the tube, will be synchronous with the signal moving down the plate line from the preceding sections.

DC Shift Compensation

DC shift in the amplifier — a condition whereby the dc and very low-frequency transconductance is less than at mid-frequencies — is compensated for in two ways. R1090 and C1093B, in plate line L1104, and R1095 and C1093D in plate line L1114, form a low-frequency boost network; the time constant of this network is such that the termination resistance of the line is increased in the range from very low frequencies to dc. A longer time constant, for extremely low-frequency and dc compensation, is provided by R1092, R1094 and C1093A in one plate line, and by R1097, R1099 and C1093C in the other, which provide a small amount of positive feedback from the plate lines to the plate circuits of the Input Amplifier. A variable resistor R1091, the DC Shift control, is connected between the two networks to adjust for the proper amount of compensation.

Beam-Positioning Indicators

The beam-position indicators B1083 and B1087, located on the front panel above the crt, indicate the relative vertical position of the trace with respect to the center of the graticule. When the beam is centered vertically, the potential across either neon is insufficient to light it. As the beam is positioned up or down the screen, however, the current through the Indicator Amplifiers, and hence the voltage across the neons, will change. The voltage across one neon will increase, causing it to light, and the voltage across the other will decrease, causing it to remain extinguished. The neon that lights will indicate the direction in which the beam has been moved.

Trigger Pickoff

When internal triggering of the Time Base Generator is desired (black TRIGGER SLOPE knob in either the + or

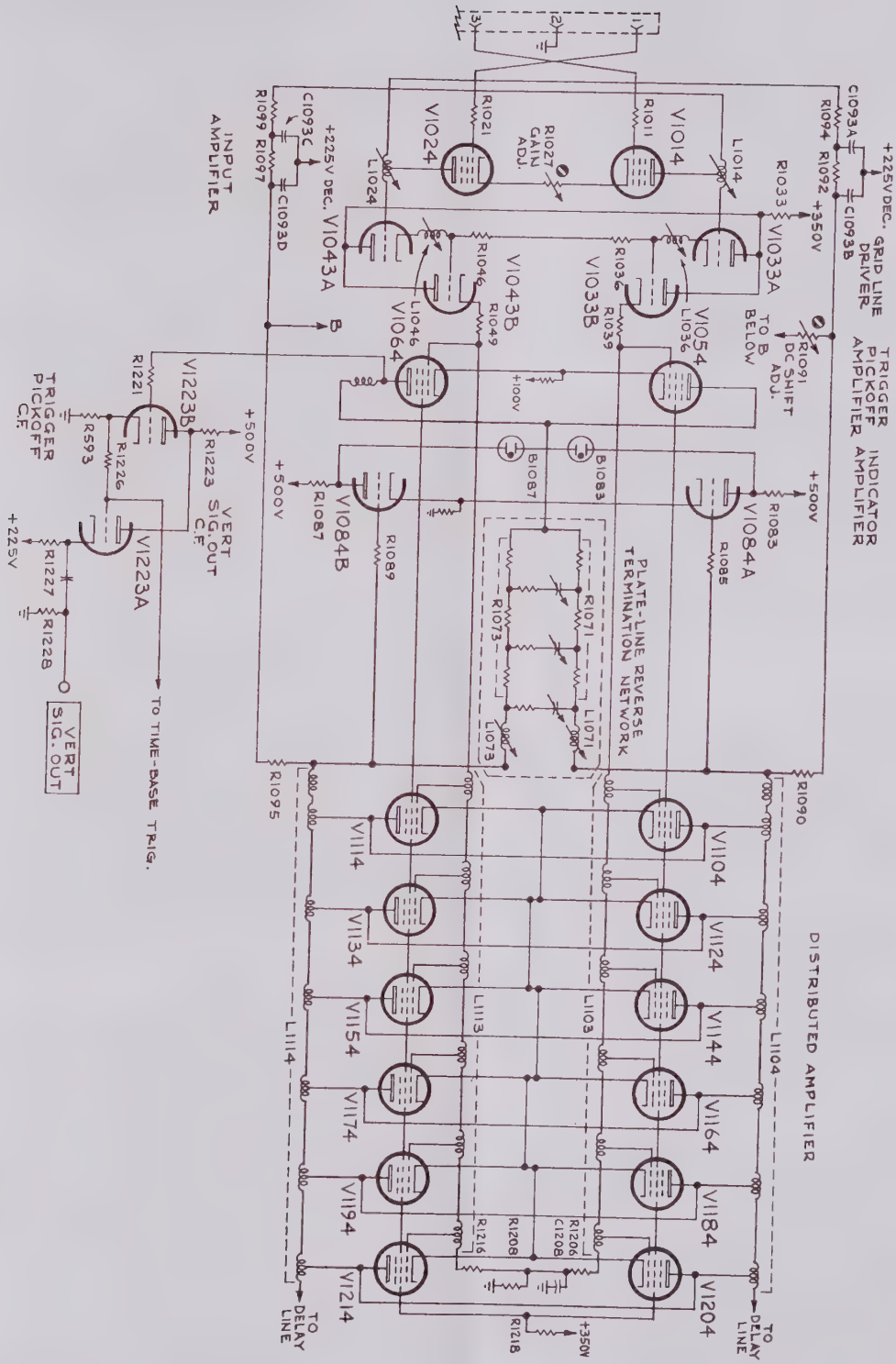
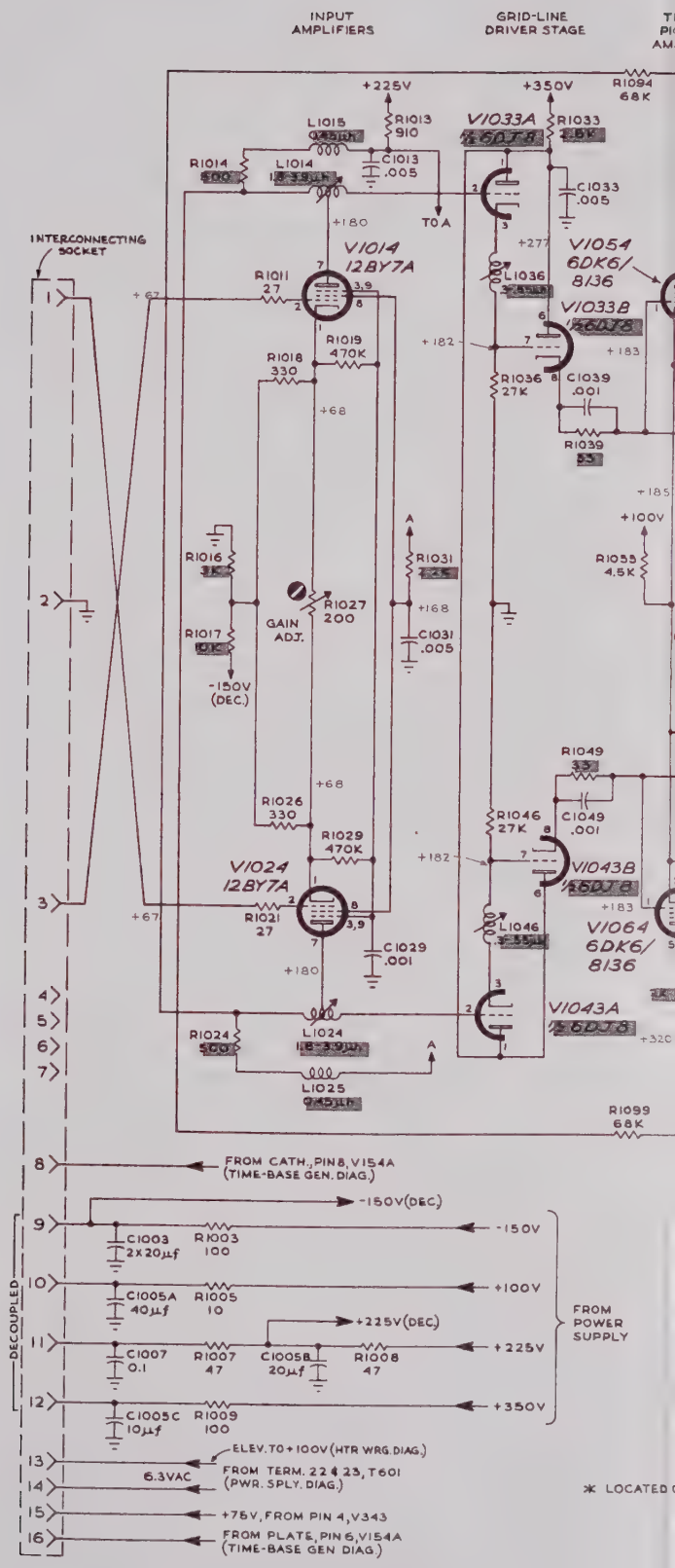
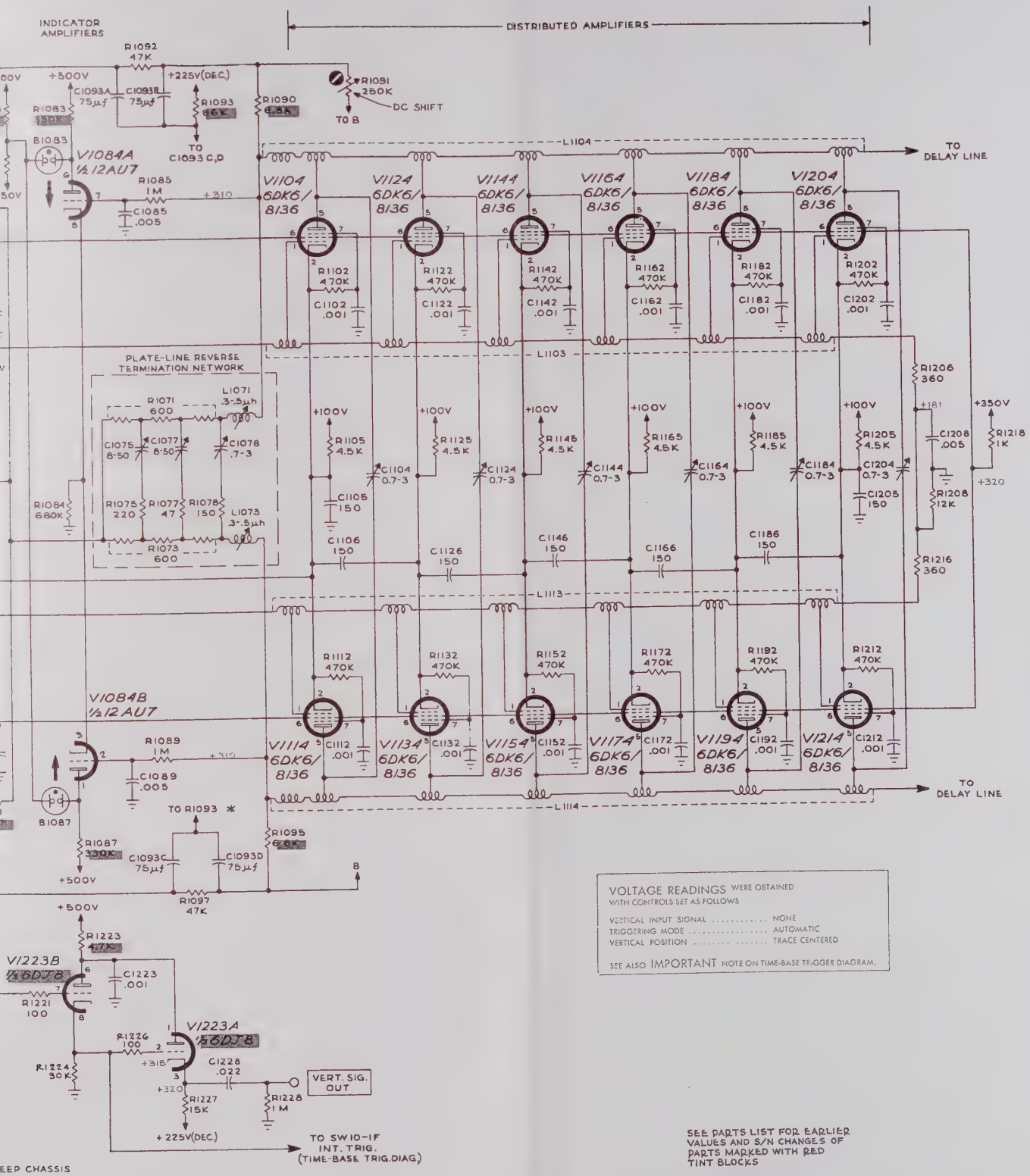


Fig. 4-1. Simplified Type 543/543A Vertical Amplifier Circuitry.



TYPE 543/543A OSCILLOSCOPE


INDICATOR AMPLIFIERS
DISTRIBUTED AMPLIFIERS
R1092 47K
+500V
+225V(DEC.)
C1093A 75µf
C1093B 75µf
R1083 13K
R1093 6.6K
R1090 4.5K
R1091 250K
DC SHIFT
TO B
TO C1093 C,D
B1083
V1084A 1/2 12AU7
R1085 1M
C1085 .005
+310
L1104
TO DELAY LINE
V1104 6DK6/8136
V1124 6DK6/8136
V1144 6DK6/8136
V1164 6DK6/8136
V1184 6DK6/8136
V1204 6DK6/8136
R1102 470K
R1122 470K
R1142 470K
R1162 470K
R1182 470K
R1202 470K
C1102 .001
C1122 .001
C1142 .001
C1162 .001
C1182 .001
C1202 .001
L1103
PLATE-LINE REVERSE TERMINATION NETWORK
R1071 600
L1071 .3-.5µh
C1075 8-50
C1077 8-50
C1078 .7-3
R1084 680K
R1075 220
R1077 47
R1078 150
L1073 .3-.5µh
R1073 600
+100V
R1105 4.5K
R1125 4.5K
R1145 4.5K
R1165 4.5K
R1185 4.5K
R1205 4.5K
C1104 0.7-3
C1124 0.7-3
C1144 0.7-3
C1164 0.7-3
C1184 0.7-3
C1204 0.7-3
C1105 150
C1106 150
C1126 150
C1146 150
C1166 150
C1186 150
C1205 150
R1206 360
+181
+350V
C1208 .005
R1218 1K
+320
R1208 12K
R1216 360
L1113
R1112 470K
R1132 470K
R1152 470K
R1172 470K
R1192 470K
R1212 470K
V1084B 1/2 12AU7
R1089 1M
C1089 .005
V1114 6DK6/8136
V1134 6DK6/8136
V1154 6DK6/8136
V1174 6DK6/8136
V1194 6DK6/8136
V1214 6DK6/8136
C1112 .001
C1132 .001
C1152 .001
C1172 .001
C1192 .001
C1212 .001
L1114
TO DELAY LINE
B1087
TO R1093 *
R1087 330K
R1095 6.6K
C1093C 75µf
C1093D 75µf
+500V
R1097 47K
8
+500V
R1223 47K
V1223B 6DJ8/6922
C1223 .001
R1221 100
V1223A 6DJ8/6922
R1226 100
+318
R1224 30K
C1228 .022
+320
R1227 15K
R1228 1M
VERT. SIG. OUT
+225V(DEC.)
TO SW10-1F INT. TRIG. (TIME-BASE TRIG.DIAG.)
EEP CHASSIS
VOLTAGE READINGS WERE OBTAINED WITH CONTROLS SET AS FOLLOWS
VERTICAL INPUT SIGNAL ..... NONE
TRIGGERING MODE ..... AUTOMATIC
VERTICAL POSITION ..... TRACE CENTERED
SEE ALSO IMPORTANT NOTE ON TIME-BASE TRIGGER DIAGRAM.
SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED WITH RED TINT BLOCKS
CIRCUIT NUMBERS 1000 THRU 1219
CMD 10-5-62
VERTICAL AMPLIFIER
AE

—INT. position), a "sample" of the vertical signal is used to develop the triggering pulse. This "sample" is obtained from the Trigger Pickoff circuit consisting of the Trigger Pickoff Amplifier V1054 and V1064, the Trigger Pickoff C.F. V1223B.

This "sample" of the vertical signal is also ac-coupled, through V1223A and C1228, to a front-panel binding post labeled VERT. SIG. OUT.

Delay Line

The output signal from the Vertical Amplifier is coupled through the balanced Delay Line to the vertical deflection plates of the crt. The function of the Delay Line is to retard the arrival of the waveform at the deflection plates until the crt has been unblanked and the horizontal sweep started. This delay, as mentioned previously, insures that the very leading edge of fast vertical signals can be observed. The line is adjusted, by means of the variable capacitors across the line, for optimum transient response.

The entire Delay Line, which includes the plate line in the Distributed Amplifier, is reverse-terminated in its characteristic impedance. The Termination Network, shown in the Vertical Amplifier diagram, is designed to dissipate both the dc and signal energy in the line by presenting a constant resistance over the frequency range of the amplifier. The terminating resistors R1071 and R1073 are specially made, wirewound, non-inductive, distributed resistors. The 600 ohms total resistance in each is "tapered", or distributed in steps. The largest segment appears at the opposite end. Each step of the resistance is then tuned, by means of the variable capacitors, so that the network will present an optimum load to the line.

HORIZONTAL-DEFLECTION SYSTEM

Time-Base Trigger

General

The Time-Base Trigger develops a pulse which will start a cycle of action in the Time-Base Generator. To display signals below five megacycles, a TRIGGERING MODE switch allows the operator to select the type of triggered operation most suitable for the waveform to be displayed. A second switch, the TRIGGER SLOPE switch, allows the operator to select the "slope", either positive or negative, which will cause triggered operation of the sweep. To display signals above five megacycles, the Time-Base Trigger is bypassed, and the signal is applied to the Sweep-Gating Multivibrator in the Time-Base Generator. No choice of triggering slope is available in this mode.

Trigger-Input Amplifier

Triggering signals may be developed from several sources. The most common source of triggering signals uses the internal circuitry of the oscilloscope to sample the signal present in the vertical amplifier. Using an internal source of triggering signal, either triggered operation in the various triggering modes or synchronized operation is available.

Triggered or synchronized operation of the time-base circuitry may be produced from an external source. Operation in any one of the available modes is possible with external signals.

In the +Line or —Line positions of the TRIGGER SLOPE switch a voltage at the power line frequency is used to develop the triggering signal.

The Trigger-Input Amplifier is a polarity-inverting, cathode-coupled amplifier. It serves two basic functions in the Time-Base Trigger. First, it provides a source of negative-going signal to drive the following stage. Secondly, by means of the TRIGGERING LEVEL control, it enables the operator to choose the signal level at which triggered operation of the Time Base will occur.

To trigger from a negative-going signal, the grid of the V24A section is connected to the input signal source. The grid of the V24B section is connected to a dc bias source, which is adjustable with the TRIGGERING LEVEL control. This bias voltage establishes the voltage present at the plate under no-signal conditions.

The voltage at the grid of V24A and the voltage at the plate of V24B are in phase with each other; that is, they both go through ac zero in the same direction at the same time. Thus, the V24B section acts as a cathode-follower, and the signal voltage developed across the cathode resistor becomes the input signal to the V24B section.

To trigger from a positive-going signal, the grid of the V24B section is connected to the TRIGGERING LEVEL control, and the grid of the V24B section is connected to the input signal. With this configuration, the voltage at the plate of the V24B section will be 180° out of phase with the input-signal voltage.

In each of the cases outlined above, a negative-going signal is produced at the plate of the V24B section of the Trigger-Input Amplifier irrespective of the polarity of the input signal.

Also, the amplitude of the triggering signal necessary to cause operation of the following stage is determined by the setting of the TRIGGERING LEVEL control.

Trigger Multivibrator

The Trigger Multivibrator is a dc-coupled multivibrator. In the quiescent state, ready to receive a signal, the V45A section is conducting and the plate voltage is down. Since the plate is dc-coupled to the grid of the V45B section, that grid is held below cutoff. With the V45B section cut off its plate voltage is up and no output is developed.

The negative-going portion of the signal from the Trigger-Input Amplifier is required to drive the grid of the V45A section down. As the V45A section grid is driven negative, the current flow through the tube is restricted and the voltage at the plate starts to rise.

The rise in voltage at the plate of the V45A section carries the grid of the V45B section in the positive direction.

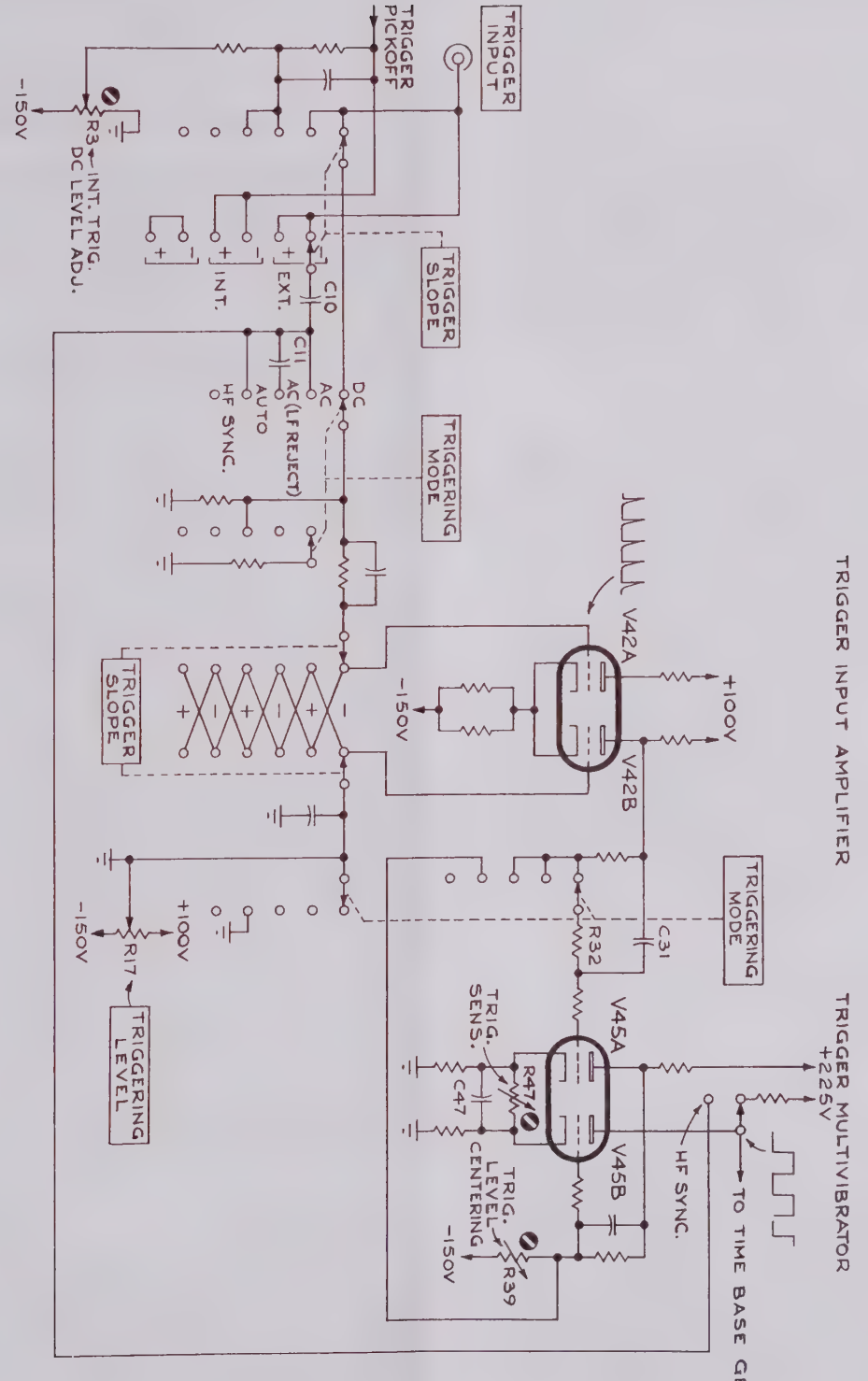
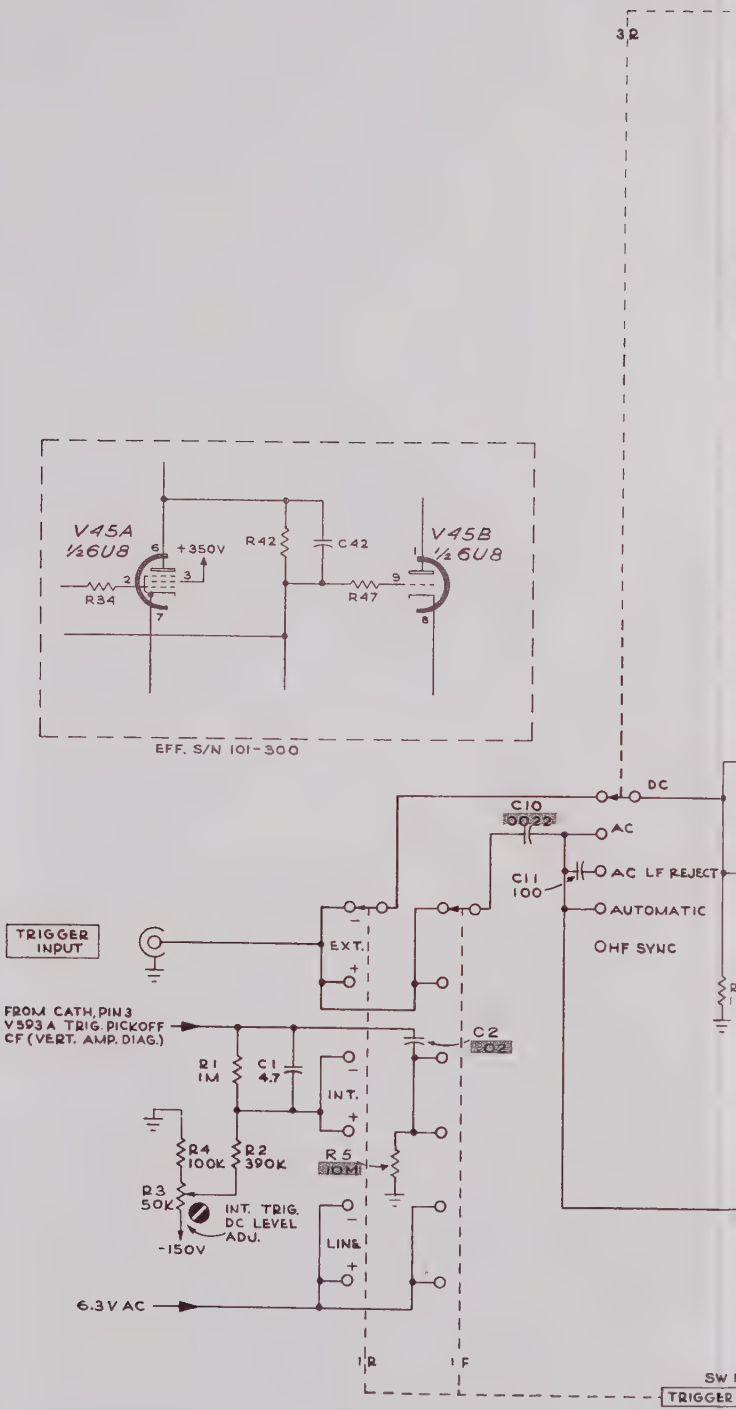
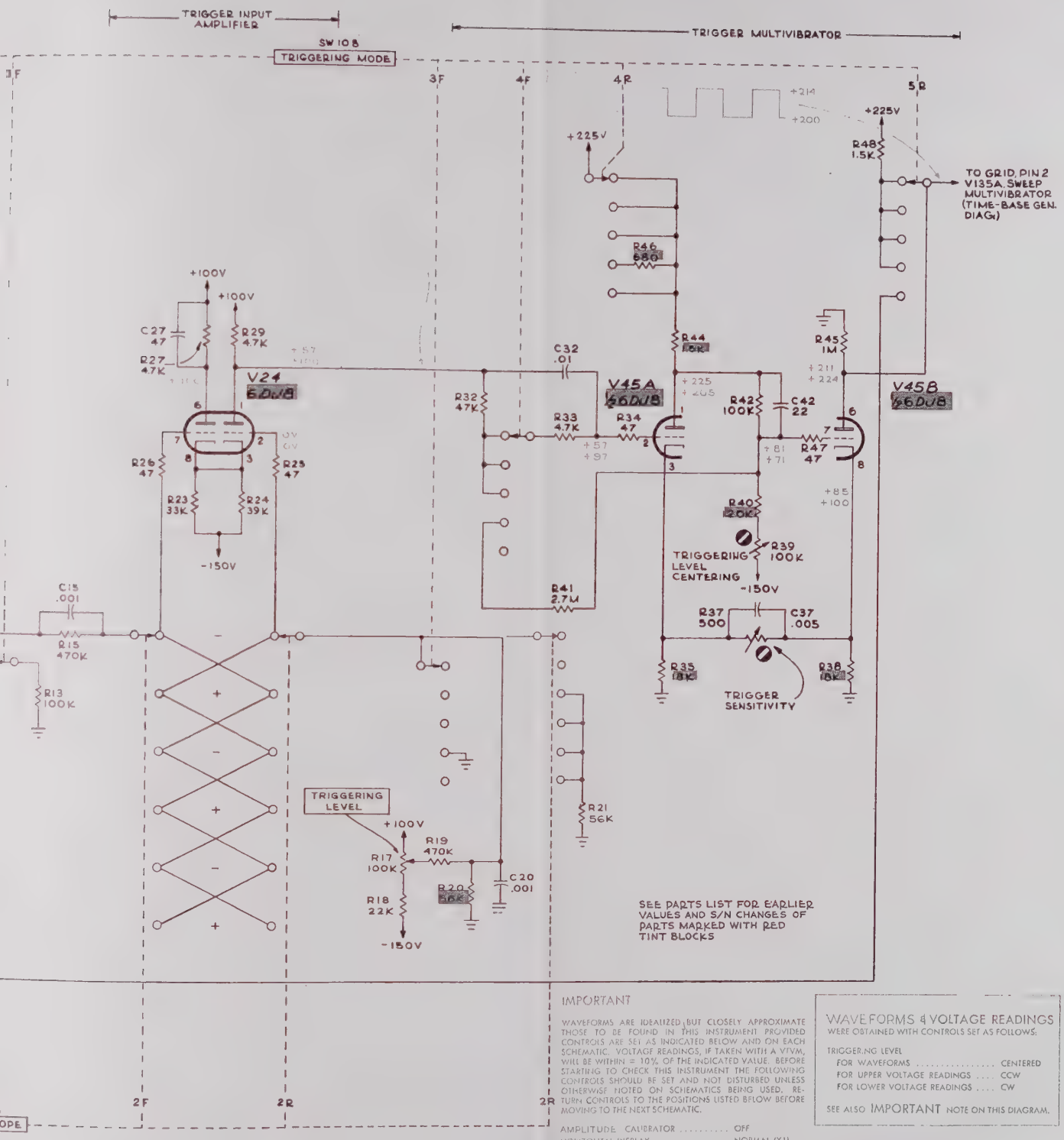


Fig. 4-2. Simplified Type 543/543A Trigger Circuitry.



TYPE 543/543A OSCILLOSCOPE



IMPORTANT

WAVEFORMS ARE IDEALIZED BUT CLOSELY APPROXIMATE THOSE TO BE FOUND IN THIS INSTRUMENT PROVIDED CONTROLS ARE SET AS INDICATED BELOW AND ON EACH SCHEMATIC. VOLTAGE READINGS, IF TAKEN WITH A VTVM, WILL BE WITHIN ± 10% OF THE INDICATED VALUE. BEFORE STARTING TO CHECK THIS INSTRUMENT THE FOLLOWING CONTROLS SHOULD BE SET AND NOT DISTURBED UNLESS OTHERWISE NOTED ON SCHEMATICS BEING USED. RETURN CONTROLS TO THE POSITIONS LISTED BELOW BEFORE MOVING TO THE NEXT SCHEMATIC.

AMPLITUDE CALIBRATOR	OFF
HORIZONTAL DISPLAY	NORMAL (X1)
VARIABLE (TIME/CM)	CW (CALIBRATED)
TIME/CM	1 mSEC
TRIGGERING MODE	AC SLOW
TRIGGER SLOPE	+LINE
TRIGGERING LEVEL	CENTERED

WAVEFORMS & VOLTAGE READINGS

WERE OBTAINED WITH CONTROLS SET AS FOLLOWS:

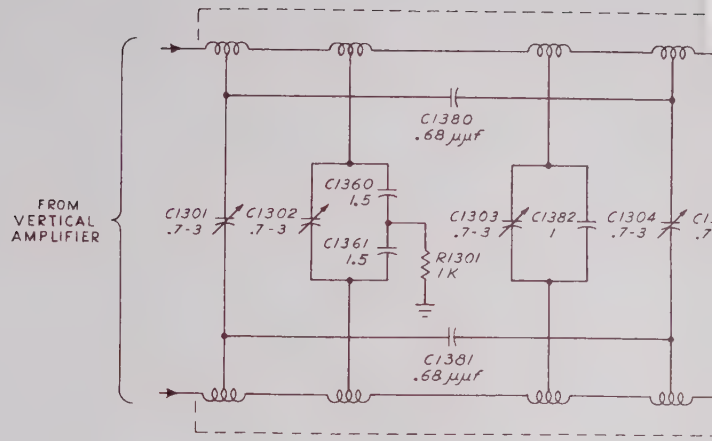
TRIGGERING LEVEL	
FOR WAVEFORMS	CENTERED
FOR UPPER VOLTAGE READINGS	CCW
FOR LOWER VOLTAGE READINGS	CW

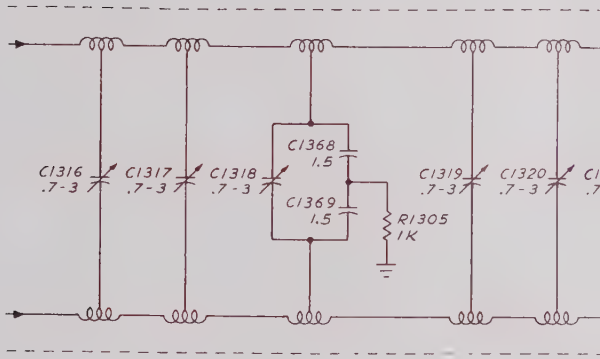
SEE ALSO IMPORTANT NOTE ON THIS DIAGRAM.

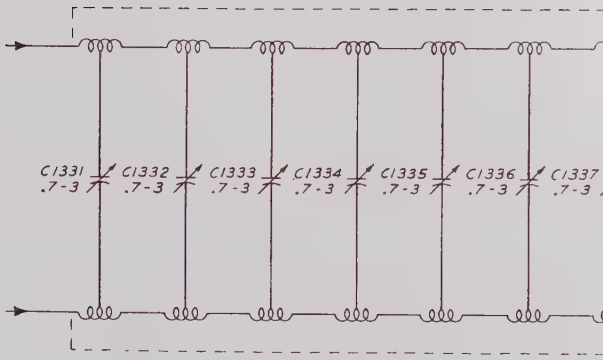
CIRCUIT NUMBERS 1 THRU 49

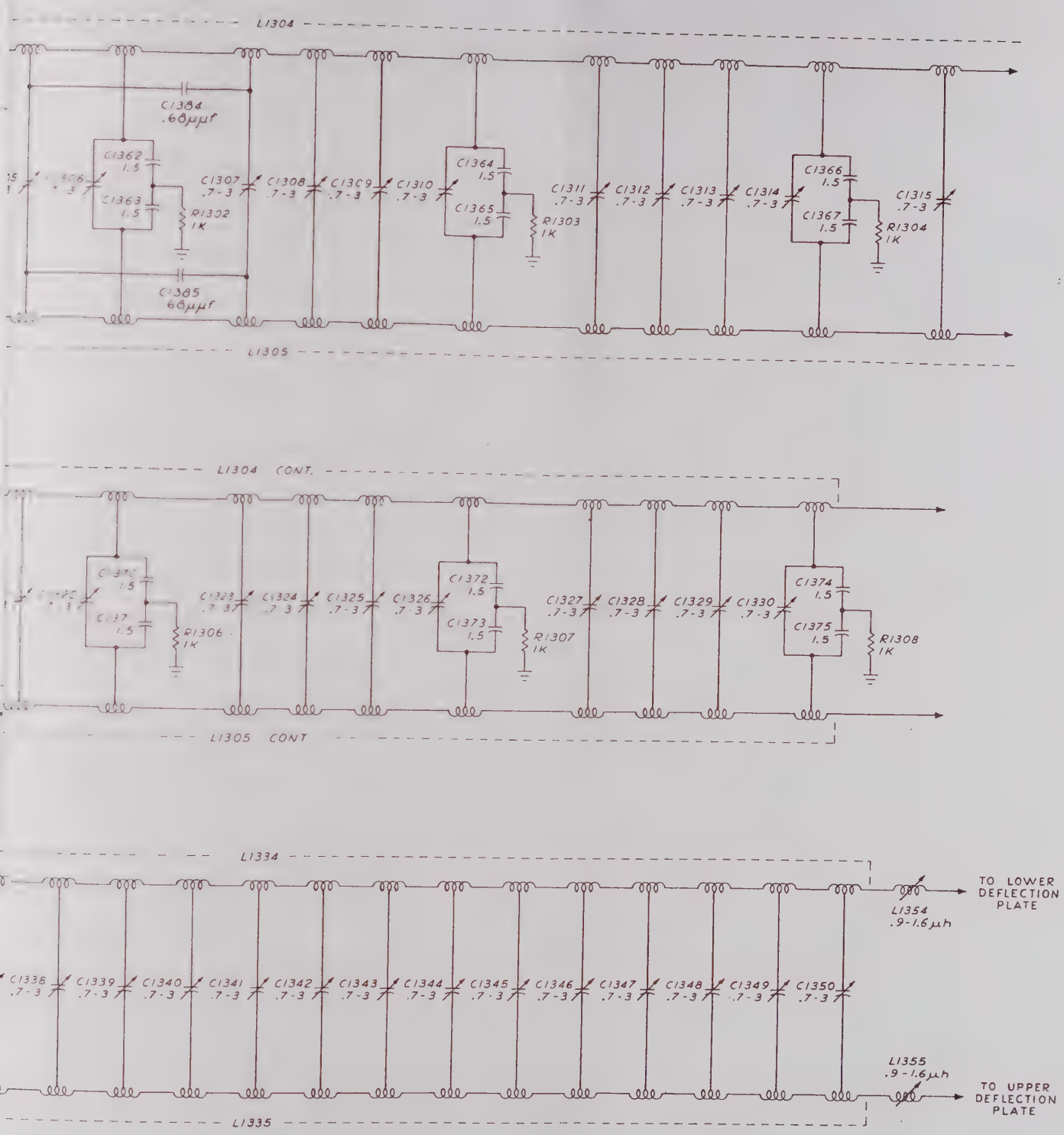
JN 1263

TIME-BASE TRIGGER


FROM VERTICAL AMPLIFIER
C1380 .68 μμf
C1360 1.5
C1361 1.5
C1301 .7-3
C1302 .7-3
C1303 .7-3
C1382 1
C1304 .7-3
R1301 1K
C1381 .68 μμf


C1316 .7-3
C1317 .7-3
C1318 .7-3
C1368 1.5
C1369 1.5
R1305 1K
C1319 .7-3
C1320 .7-3


C1331 .7-3
C1332 .7-3
C1333 .7-3
C1334 .7-3
C1335 .7-3
C1336 .7-3
C1337 .7-3



CIRCUIT NUMBERS 1300 THRU 1389

JR
10-16-62

DELAY LINE NETWORK

AA,

The cathodes of both sections are coupled together, and follow the action of the grids. With the V45B section grid going in a positive direction, and the cathode in a negative direction, the V45B section starts to conduct. As the V45B section starts to conduct, the cathodes of both sections follow the action of the V45B section grid; hence the cathode voltage starts to rise.

As the V45A section grid goes down and its cathode goes up, it stops conducting. As the V45B section conducts, its plate voltage drops, creating a negative step at the output. This transition occurs rapidly, regardless of how slowly the V45A grid falls.

When the signal applied to the grid of the V45A section goes in a positive direction the action described in the previous paragraphs reverses itself. That is, the V45A section will start to conduct once more, while the V45B section will be cut off.

In the AUTO. position of the TRIGGERING MODE switch the Trigger Multivibrator is converted from a bistable configuration to a recurrent configuration. This is done by coupling the grid circuit of the V45A section to the grid circuit of the V45B section. In addition, the dc coupling between the grid of the V45A section of the Trigger Multivibrator and the plate of the V25B section of the Trigger-Input Amplifier is replaced by ac coupling.

In the AUTO. triggering mode the Trigger Multivibrator will free run in the absence of a triggering signal. For example, assume that the grid of the V45A section is just being driven into cutoff. The voltage at the plate of the V45A section starts to rise, carrying with it the grid of the V45B section. As the voltage at the grid of the V45B section starts to rise, the V45B section starts to conduct.

The rising voltage at the grid of the V45B section is coupled to the grid of the V45A section through R41. The grid of V45A is prevented from rising immediately by the action of C32, which must be charged sufficiently to raise the voltage at the grid of the V45A section above cutoff.

As the V45A section starts to conduct, its plate voltage drops, which in turn lowers the voltage at the grid of the V45B section. The voltage at the grid of V45A starts dropping exponentially toward cutoff. When the V45A section reaches cutoff, the circuit has completed one cycle of approximately 50-cycle repetition rate.

The Trigger Multivibrator produces a square-wave which is coupled to the Time-Base Generator. This square wave is differentiated in the Time-Base Generator to produce a sharp, negative-going pulse which is used to trigger the Time-Base Generator in the proper time sequence when triggered operation is desired. For synchronized operation of the Time-Base Generator, the TRIGGERING MODE switch is placed in the HF SYNC position. This couples the signal present at the Input of the Time-Base Trigger directly into the Time-Base Generator, and the Time-Base Trigger circuitry is not used in the HF SYNC mode.

Time-Base Generator

General

The Trigger circuit produces a negative-going waveform which is coupled to the Time-Base Generator. This waveform is differentiated in the grid circuit of V135A to produce a sharp negative-going triggering pulse to trigger the Time-Base Generator in the proper time sequence. Positive-going pulses are also produced in the differentiation process, but they are not used in the operation of the Time-Base Generator.

The Time-Base Generator consists of three main circuits; a Sweep-Gating Multivibrator, a Miller-Runup Circuit, and a Holdoff Circuit. The Sweep-Gating Multivibrator consists of V135A, V146 and the cathode follower V135B. The essential components of the Miller-Runup Circuit are the Miller Tube V161, the Runup C.F. V173, the On-Off Diodes V152, the Timing Capacitor C160 and the Timing Resistor R160. The Holdoff circuit consists of the Hold-Off C.F.'s V183A-V133B, the Holdoff Capacitor C180 and the Holdoff Resistors R181-R180. Essential circuitry of the Time-Base Generator is shown in Fig. 4-3.

Sweep-Gating Multivibrator

The Sweep-Gating Multivibrator operates as a bistable circuit. In the quiescent state V135A is conducting and its plate is down. This cuts off V146 through V135B and the divider R141-R143, and the common cathode resistor R144. With V146 cutoff, its plate is clamped about 3 volts below ground by conduction of diodes V152A and B through R147 and R148. Conduction of the lower diode V152A through the Timing Resistor R160 then clamps the grid of the Miller tube at about —3.5 volts.

Miller-Runup Circuit

The quiescent state of the Miller circuit is determined by a dc network between plate and grid. This network consists of the neon glow tube B167, the Runup C.F. V173 and the On-Off Diodes V152. The purpose of this network is to establish a voltage at the plate of the Miller tube of such a value that the tube will operate above the knee, and thus over the linear region, of its characteristic curve. This quiescent plate voltage is about +43 volts.

Sweep Generation

If the STABILITY and TRIGGERING LEVEL controls are now adjusted for triggered operation, a negative trigger will drive the grid of V135A below cutoff and force the Sweep-Gating Multivibrator into its other state in which V146 is the conducting tube. As V146 conducts its plate drops, cutting off the On-Off Diodes V152. Any spiking that may occur during this transition is attenuated by the C150-R150 network.

With V152 cut off, the grid of the Miller tube and the cathode of the Runup C.F. are free to seek their own voltages. The grid of the Miller tube then starts to drop, since it is connected to the —150 volt bus through the Timing Resistor R160. The plate of the Miller tube starts to rise, carrying with it the grid and cathode of V173. This raises the voltage at the top of the Timing Capacitor C160, which in turn pulls up the grid of the Miller tube and prevents it from dropping. The gain of the Miller

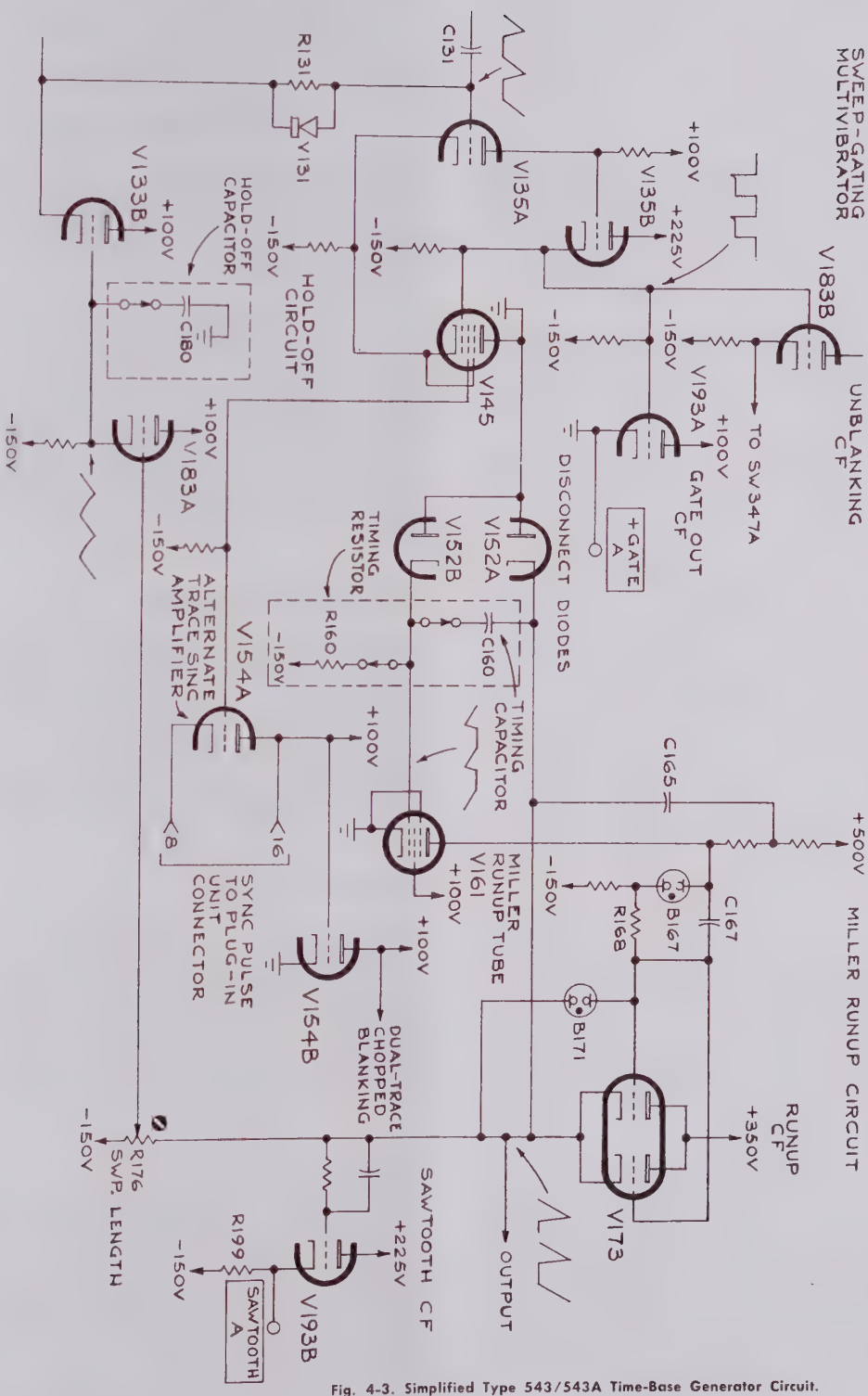
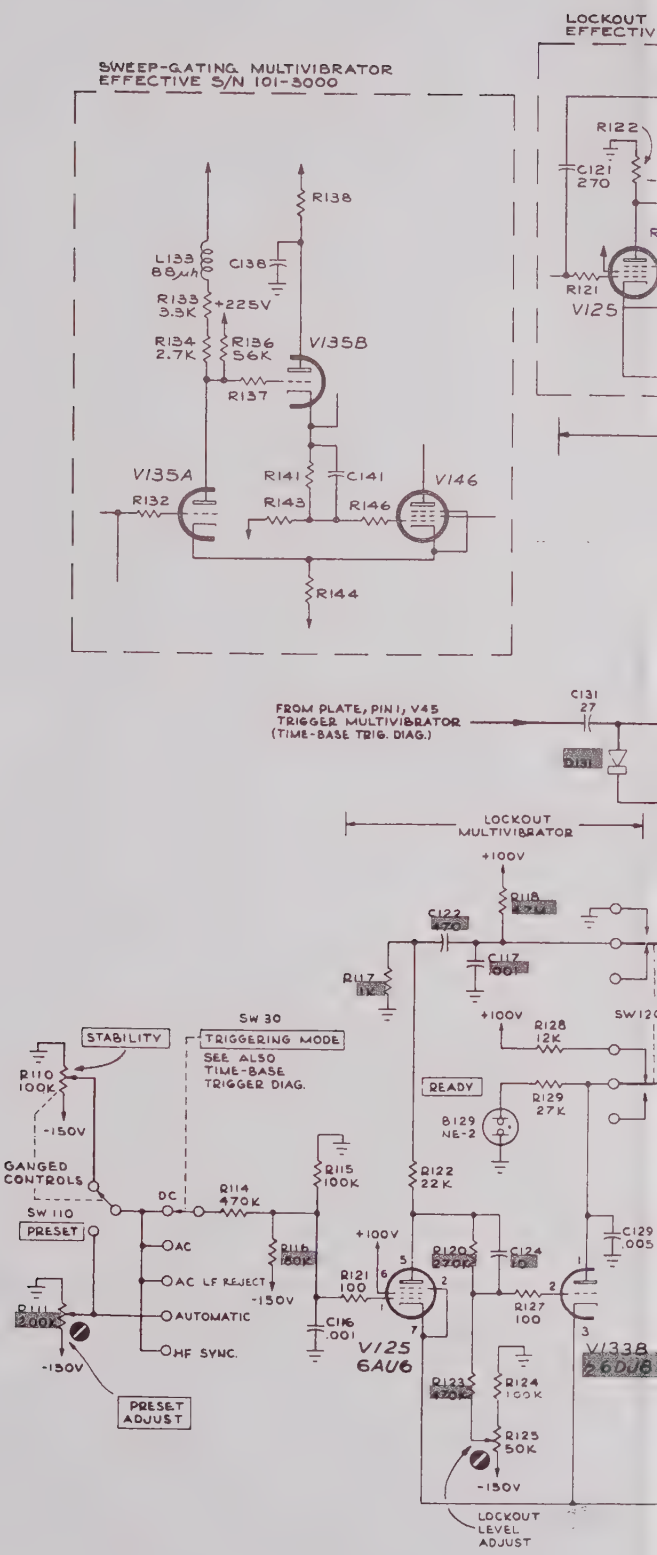
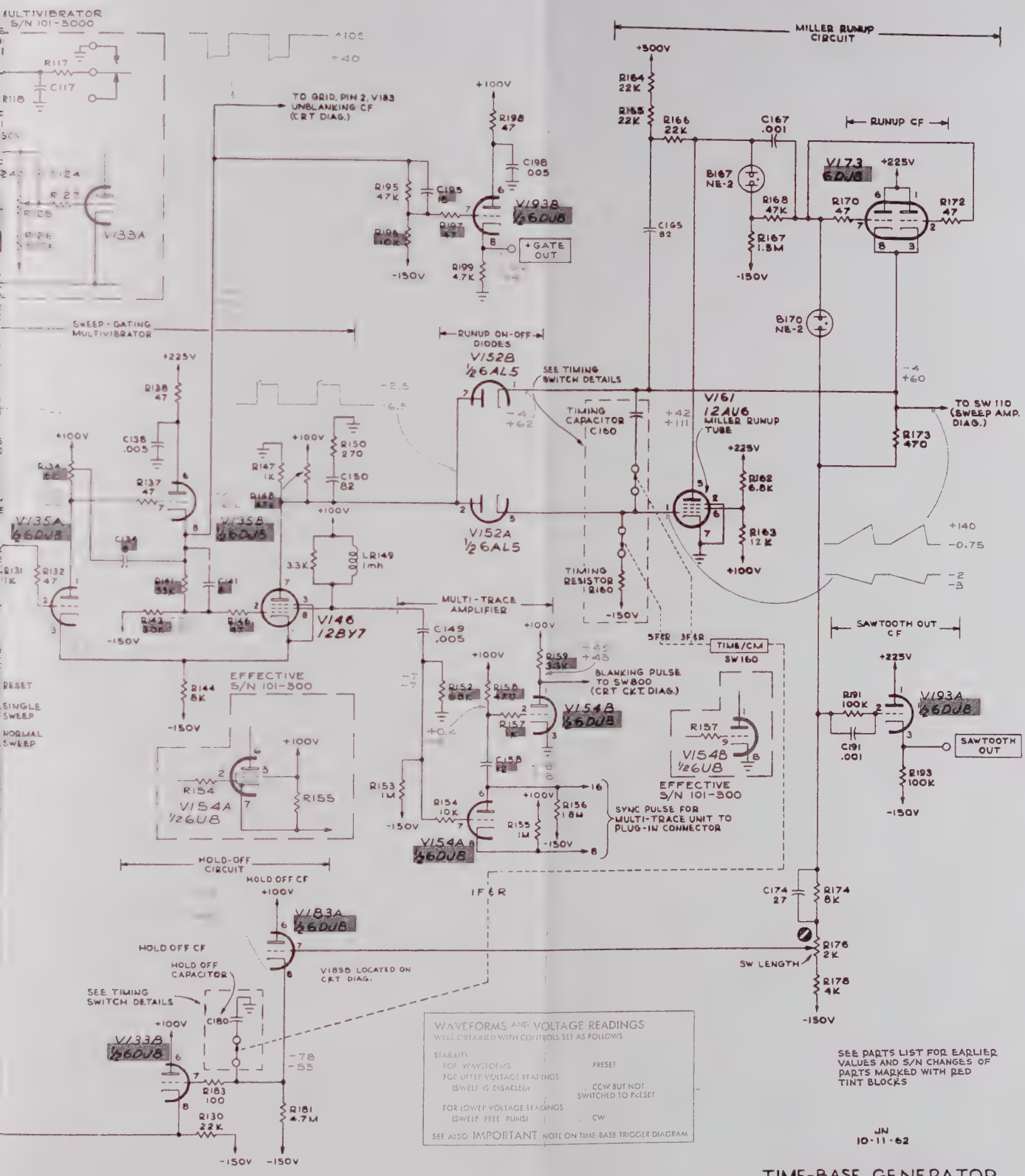


Fig. 4-3. Simplified Type 543/543A Time-Base Generator Circuit.



TYPE 543/543A OSCILLOSCOPE


MULTIVIBRATOR S/N 101-3000
MILLER RUNUP CIRCUIT
RUNUP CF
TO GRID, PIN 2, V183 UNBLANKING CF (CRT DIAG.)
+GATE OUT
SWEEP-GATING MULTIVIBRATOR
RUNUP ON-OFF DIODES
SEE TIMING SWITCH DETAILS
TIMING CAPACITOR C160
TIMING RESISTOR R160
MILLER RUNUP TUBE
TO SW 110 (SWEEP AMP. DIAG.)
MULTI-TRACE AMPLIFIER
BLANKING PULSE TO SW800 (CRT CKT. DIAG.)
TIME/CM SW160
SAWTOOTH OUT CF
SAWTOOTH OUT
EFFECTIVE S/N 101-300
SYNC PULSE FOR MULTI-TRACE UNIT TO PLUG-IN CONNECTOR
HOLD-OFF CIRCUIT
HOLD OFF CF
HOLD OFF CAPACITOR
V183D LOCATED ON CRT DIAG.
SW LENGTH
IF & ER
RESET
SINGLE SWEEP
NORMAL SWEEP
WAVEFORMS AND VOLTAGE READINGS
WERE OBTAINED WITH CONTROLS SET AS FOLLOWS
STABILITY
FOR WAVEFORMS . . . PRESET
FOR LOWER VOLTAGE READINGS (SWEEP IS DISABLED) . . . CCW BUT NOT SWITCHED TO PRESET
FOR LOWER VOLTAGE READINGS (SWEEP FREE RUNS) . . . CW
SEE ALSO IMPORTANT NOTE ON TIME-BASE TRIGGER DIAGRAM
SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED WITH RED TINT BLOCKS
JN 10-11-62
TIME-BASE GENERATOR
CIRCUIT NUMBERS 110 THRU 199
AA4

tube, as a Class A amplifier, is so high that the voltage coupled back through C-160 keeps the grid constant within a fraction of a volt.

The Timing Capacitor then starts charging with current from the —150 volt bus. This charging current flows through the Timing Resistor R160. Since the voltage at the grid of the Miller tube remains essentially constant, the voltage drop across the Timing Resistor remains essentially constant. This provides a constant source of current for charging C160. By this action C160 charges linearly, and the voltage at the cathode of V173 rises linearly. Any departure from a linear rise in voltage at this point will produce a change in the voltage at the grid of the Miller tube in a direction to correct for the error.

Timing Switch

The linear rise in voltage at the cathode of V173 is used as the sweep time-base. Timing Capacitor C160 and Timing Resistor R160 are selected by the TIME/CM switch SW160. R160 determines the current that charges C160. By means of the TIME/CM switch both the size of the capacitor being charged and the charging current can be selected to cover a wide range of sawtooth slopes (sweep rates). For high speed sweeps bootstrap capacitor C165 helps supply current to charge the stray capacitance at the plate of the Miller tube. This permits the plate voltage to rise at the required rate.

If uncalibrated sweep rates are desired, the VARIABLE TIME/CM (red knob) control may be turned away from the CALIBRATED position. This control, R160Y, varies the sweep rate over 2½ to one range. Switch 160B is ganged with the VARIABLE control in such a way that the UNCALIBRATED light comes on when the control is turned away from the CALIBRATED position.

Sweep Length

As explained previously, the sweep rate (the rate at which the spot moves across the face of the crt) is determined by the timing circuit C160 and R160. The length of the sweep (the distance the spot moves across the face of the crt), however, is determined by the setting of the SWP. LENGTH control R176. This will increase the voltage at the grid and cathode at V183A and at the grid and cathode of V133B. As the voltage at the cathode of V133B rises, the voltage at the grid of V135A will rise. When the voltage at this point is sufficient to bring V135A out of cutoff, the multivibrator circuit will rapidly revert to its original state with V135A conducting and V146 cut off. The voltage at the plate of V146 rises, carrying with it the voltage at the diode plate V152A. The diode then conducts and provides a discharge path for C160 through R147 and R148 and through the resistance of the cathode circuit of V173. The plate voltage of the Miller Tube now falls linearly, under feedback conditions essentially the same as when it generated the sweep portion of the waveform except for a reversal of direction. The resistance through which C160 discharges is much less than that of the Timing Resistor (through which it charges). The capacitor current for this period will therefore be much larger than during the sweep portion, and the plate of the Miller Tube will return rapidly to its quiescent voltage. This produces the retrace portion of the sweep sawtooth during which time the crt beam returns rapidly to its starting point.

Holdoff

The Holdoff Circuit prevents the Time-Base Generator from being triggered during the retrace interval. That is, the Holdoff allows a finite time for the Time-Base circuits to regain a state of equilibrium after the completion of a sweep.

During the trace portion of the sweep sawtooth, the Holdoff Capacitor C180 charges through V183A, as a result of the rise in voltage at the cathode of V183A. At the same time the grid of V135A is being pulled up, through V133B, until V135A comes out of cutoff and starts conducting. As mentioned previously, this is the action that initiates the retrace. At the start of the retrace interval C180 starts discharging through the Holdoff Resistor R181. The time constant of this circuit is long enough, however, so that during the retrace interval (and for a short period of time after the completion of the retrace) C180 holds the grid of V135A high enough so that it cannot be triggered. However, when C180 discharges to the point where V133B is cutoff, it loses control over the grid of V135A and this grid returns to the level established by the STABILITY control. The holdoff time required is determined by the size of the Timing Capacitor. For this reason the TIME/CM switch changes the time constant of the Holdoff Circuit simultaneously with the change of Timing Capacitors. (In the μSEC positions of the TIME/CM switch R181 is shunted by either R180A or R180B, shown on the Timing Switch diagram.)

Stability

The operational mode of the Time-Base Generator is determined by the setting of the STABILITY control R110. By means of this control the sweep can be turned off, adjusted for triggered operation. The STABILITY control, through cathode follower V125, regulates the grid level of V135A. (V133A is inoperative for NORMAL SWEEP operation.)

For triggered operation, the STABILITY control is adjusted so that the grid of V135A is just high enough to prevent the Sweep-Gating Multivibrator from free running. Adjusted in this manner a sweep can only be produced when an incoming negative trigger pulse drives the grid of V135A below cutoff.

Moving the arm of the STABILITY control toward ground, (ccw rotation), but not so far as to actuate the PRESET switch, will raise the grid level of V135A and prevent the Sweep-Gating Multivibrator from being triggered. This action turns off the sweep. Moving the arm toward —150 volts drops the grid of V135A to the point where the discharge of the Holdoff Capacitor C180 can switch the multivibrator. Adjusted in this manner, the Sweep-Gating Multivibrator will free run and produce a recurrent sweep.

When the STABILITY control is turned full ccw to the PRESET position, R110 is switched out of the circuit and

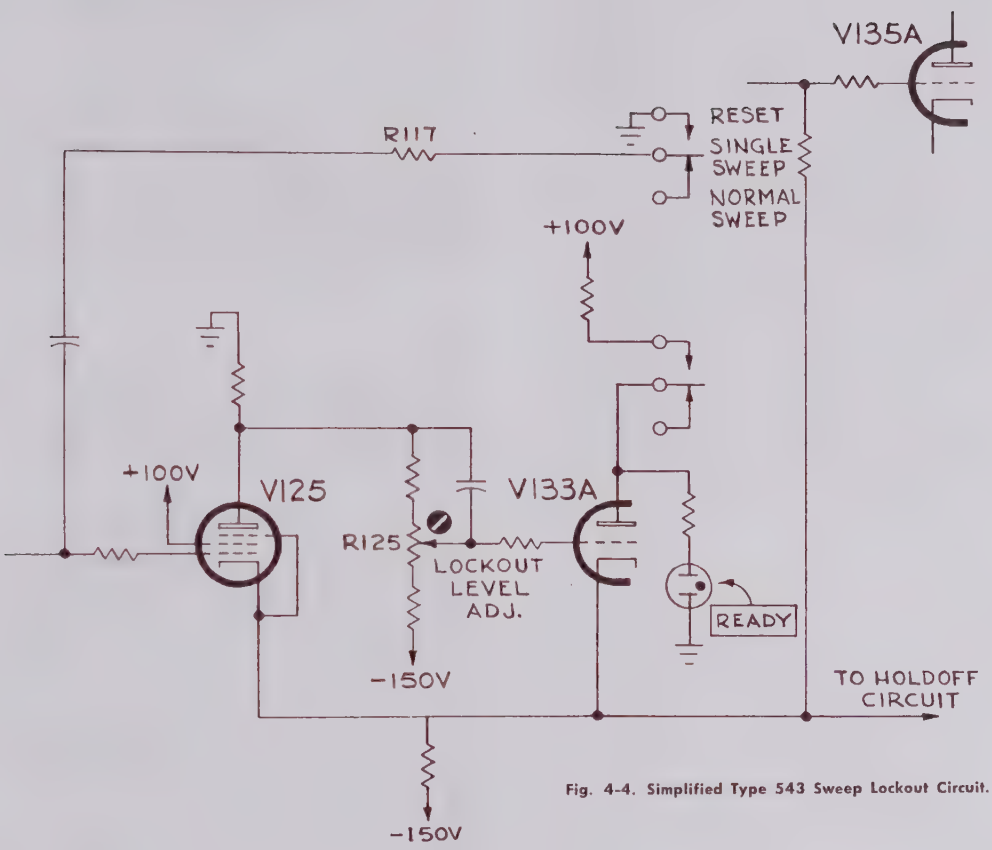


Fig. 4-4. Simplified Type 543 Sweep Lockout Circuit.

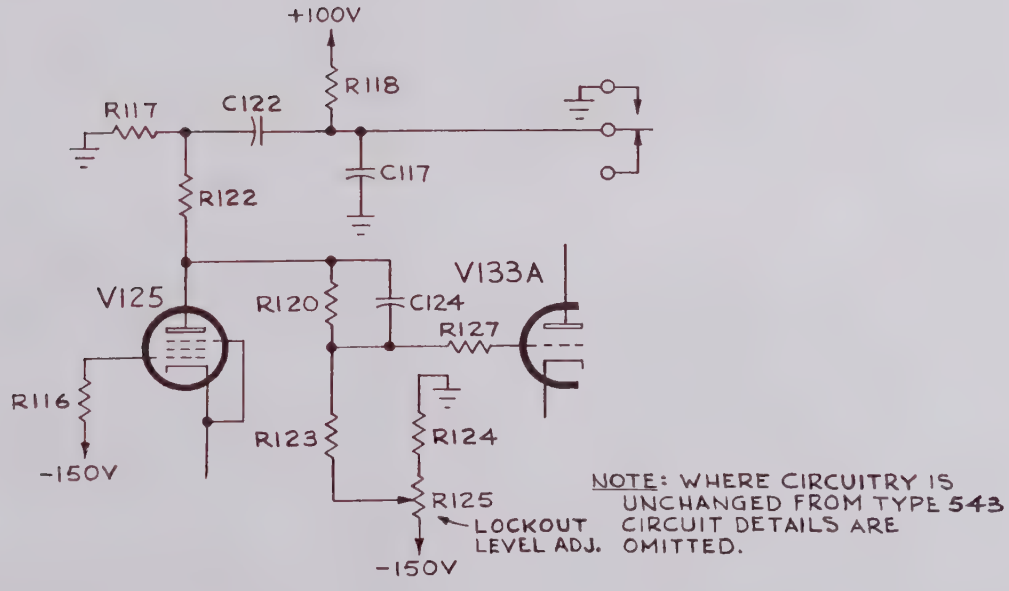
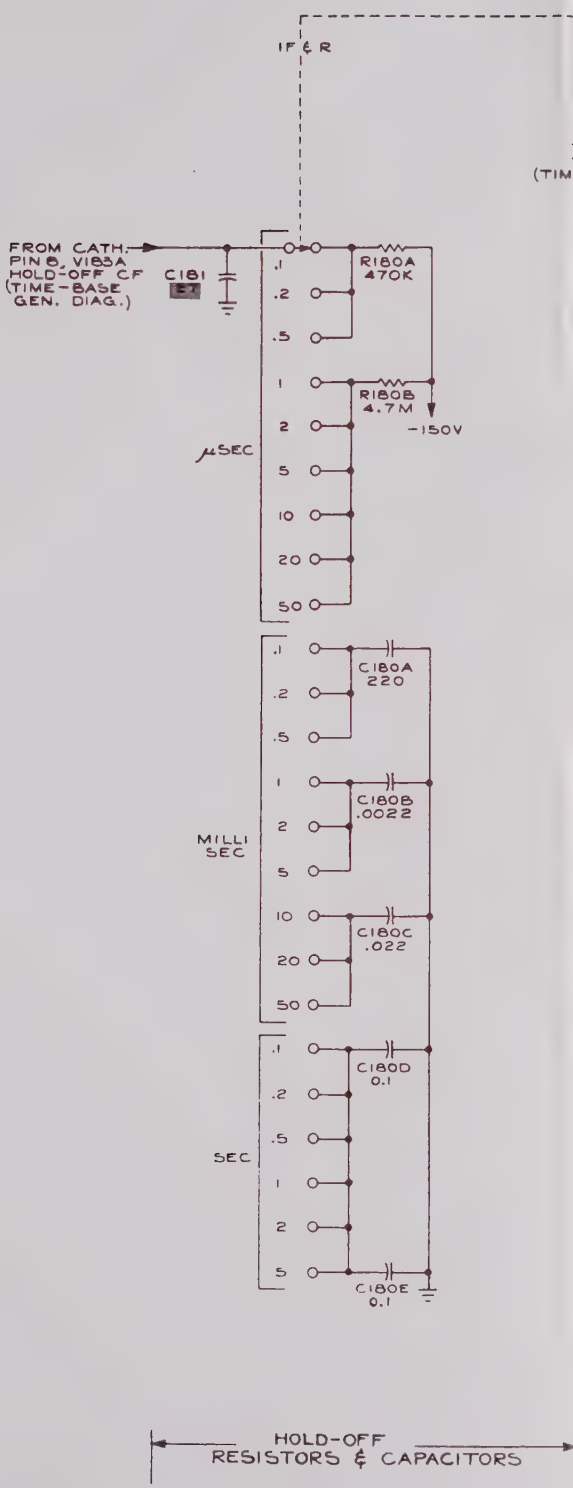
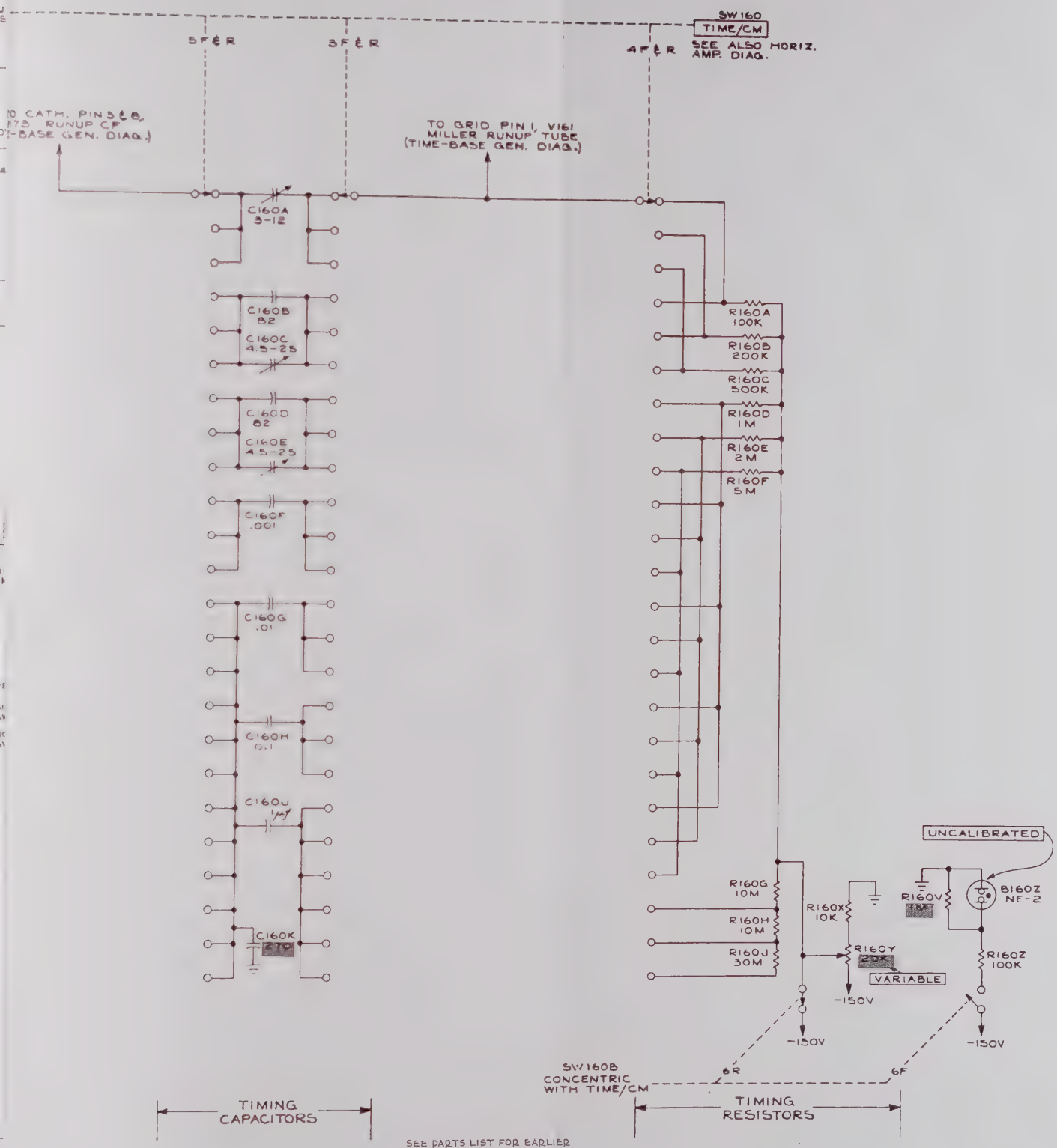


Fig. 4-5. Simplified Type 543A Sweep Lockout Circuit.


IF & R
(TIM
FROM CATH. PIN 8, V183A HOLD-OFF CF (TIME-BASE GEN. DIAG.)
C181
.1
.2
.5
1
2
5
10
20
50
μSEC
R180A 470K
R180B 4.7M
-150V
C180A 220
C180B .0022
C180C .022
MILLI SEC
C180D 0.1
SEC
C180E 0.1
HOLD-OFF RESISTORS & CAPACITORS



SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED WITH RED TINT BLOCKS

AD

PLM
09-24-62

TIMING SWITCH

R11 is switched in. This control, a front-panel screwdriver adjustment labeled PRESET ADJUST, provides a fixed dc voltage for the grid of V135A. When properly adjusted, PRESET operation can be used for most triggering applications. Where triggering may be difficult, however, the manual STABILITY control R110 should be used.

Single Sweep Operation

When the NORMAL SWEEP-SINGLE SWEEP switch is in the SINGLE SWEEP position, plate voltage is applied to V133A and this tube operates in conjunction with V125 as a bistable multivibrator.

In the first stable state that exists after the completion of a sweep, V125 is cut off and V133A is conducting. In this state, the divider between the plate of V125 and the grid of V133A sets the cathode voltage of the Lockout Multivibrator and consequently the grid voltage of V135A. The Lockout Level Adj. R125 is adjusted to set the grid of V135A high enough so that the Sweep-Gating Multivibrator cannot be triggered; this "locks out" the sweep.

There is a slight circuit difference between the Type 543 and Type 543A at this point in the Single Sweep operation. In the Type 543, depressing the RESET switch grounds C121 through R117. The resulting positive pulse at the grid of V125 forces the Lockout Multivibrator into its other stable state with V125 conducting and V133A cutoff. With V133A cutoff its plate voltage rises and ignites the READY light. With V125 conducting, the STABILITY control regains control over the grid level of V135A.

In the Type 543A, the overall circuit operation is the same, except that the RESET switch is connected into the plate circuit of V125, and depressing the button causes a sharp drop in V125 plate voltage, which, through the divider between the plate of V125 and the grid of V133A, again cuts off V133A and flips the Lockout Multivibrator into the stable state with V125 conducting.

Depending on the adjustment of the STABILITY control, a sweep can now be produced in one or two ways. If the STABILITY control is turned full right (cw) the grid of V135A will be pulled down and cause the Sweep-Gating Multivibrator to switch to its other state and initiate a sweep. If the STABILITY control is adjusted for triggered operation, the sweep will be initiated by the first negative trigger pulse to arrive at the grid of V135A.

As the sweep begins, the rising sawtooth voltage pulls up the cathode of V133B by the holdoff action previously described. As the cathodes of the Lockout Multivibrator follow the cathode of V133B up, V125 cuts off and V133A conducts. As the cathodes continue to rise, following the rise in the sawtooth sweep voltage, V133A cuts off again. Both tubes are then held cutoff for the remainder of the sweep and the READY light stays on. When the grid of V135A rises to the point where the Sweep-Gating Multivibrator is reverted, the sweep is terminated.

As the Holdoff Capacitor C180 discharges, the cathodes of the Lockout Multivibrator start to fall. The grid level of V133A is such that this tube comes out of cutoff first; thus, V133A conducts and V125 remains in cutoff. As V133A conducts, its plate drops, extinguishing the READY light. A new sweep cannot be initiated until the RESET switch is depressed again.

Unblanking

The positive rectangular pulse at the cathode of V135B in the Sweep-Gating Multivibrator circuit is coupled through a cathode follower V183B to the grid supply for the crt. This pulse, whose start and duration are coincident with the rising portion of the sawtooth sweep waveform, pulls up the grid of the crt. This unblanks the crt during the trace portion of the sweep and permits the trace to be observed.

Output Waveforms

The positive pulse coupled to the crt circuit for unblanking is also coupled through a cathode follower V193B to a front-panel binding post labeled + GATE OUT. This positive gate waveform starts at ground and rises to about +20 volts.

The sweep sawtooth voltage at the cathode of V173 is coupled through a cathode follower V193A to a front-panel binding post labeled SAWTOOTH OUT. This waveform, which starts at about ground, provides a 150-volt linear rise in voltage.

Dual-Trace Sync and Blanking

Synchronizing pulses for dual-trace plug-in preamplifiers are supplied by V154A. When multivibrator tube V146 cuts off, a sharply differentiated positive pulse is developed at its screen. This pulse, coupled to the grid of V154A, produces a negative trigger at the plate of V154A. This trigger then switches the multivibrator in the dual-trace unit employed for alternate sweeps.

When the dual-trace multivibrator is connected for free running operation to produce chopped sweeps, a negative pulse is coupled from the multivibrator to the grid of V154B. The resultant positive pulse at the plate of V154B is coupled to the cathode of the crt to blank out the beam during switching. Refer to the manual for the dual-trace unit for a detailed description of the switching multivibrator.

HORIZONTAL AMPLIFIER

The dc-coupled Horizontal Amplifier consists of a cathode-follower input stage, two stages of push-pull amplification and a cathode-follower output stage. The gain of Input Amplifier V354-V364 is controlled by negative feedback applied from the cathodes of the Output CF stage V374B-V384B. The amount of negative feedback applied to the Input Amplifier, and hence the gain of the stage, is determined by the setting of the HORIZONTAL DISPLAY switch. As the magnification factor is increased the gain is increased by decreasing the feedback.

Input Circuit

The positive-going sweep sawtooth voltage produced by the Time-Base Generator circuit is coupled through a frequency-compensated voltage divider to the grid of the

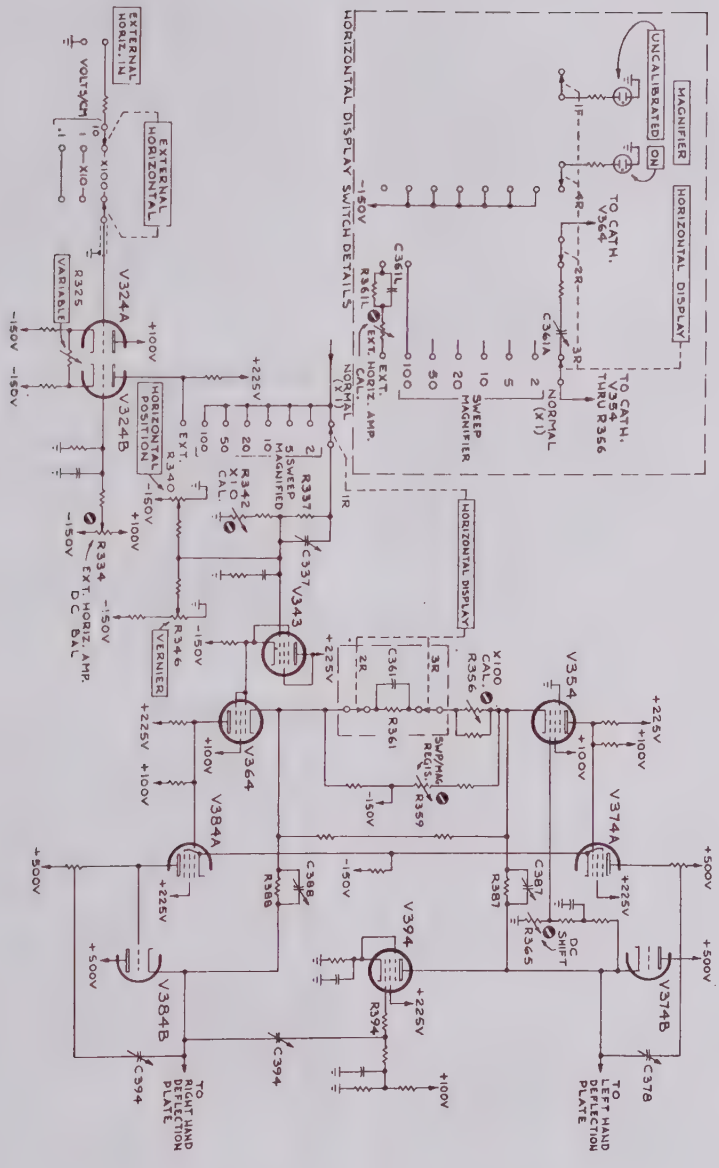
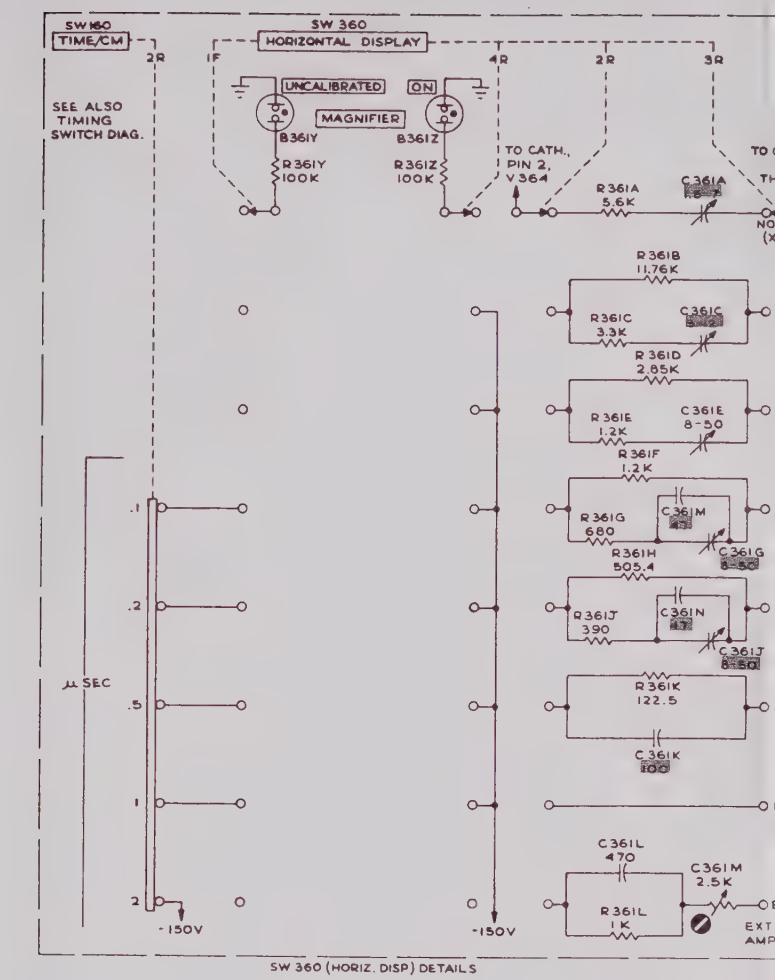
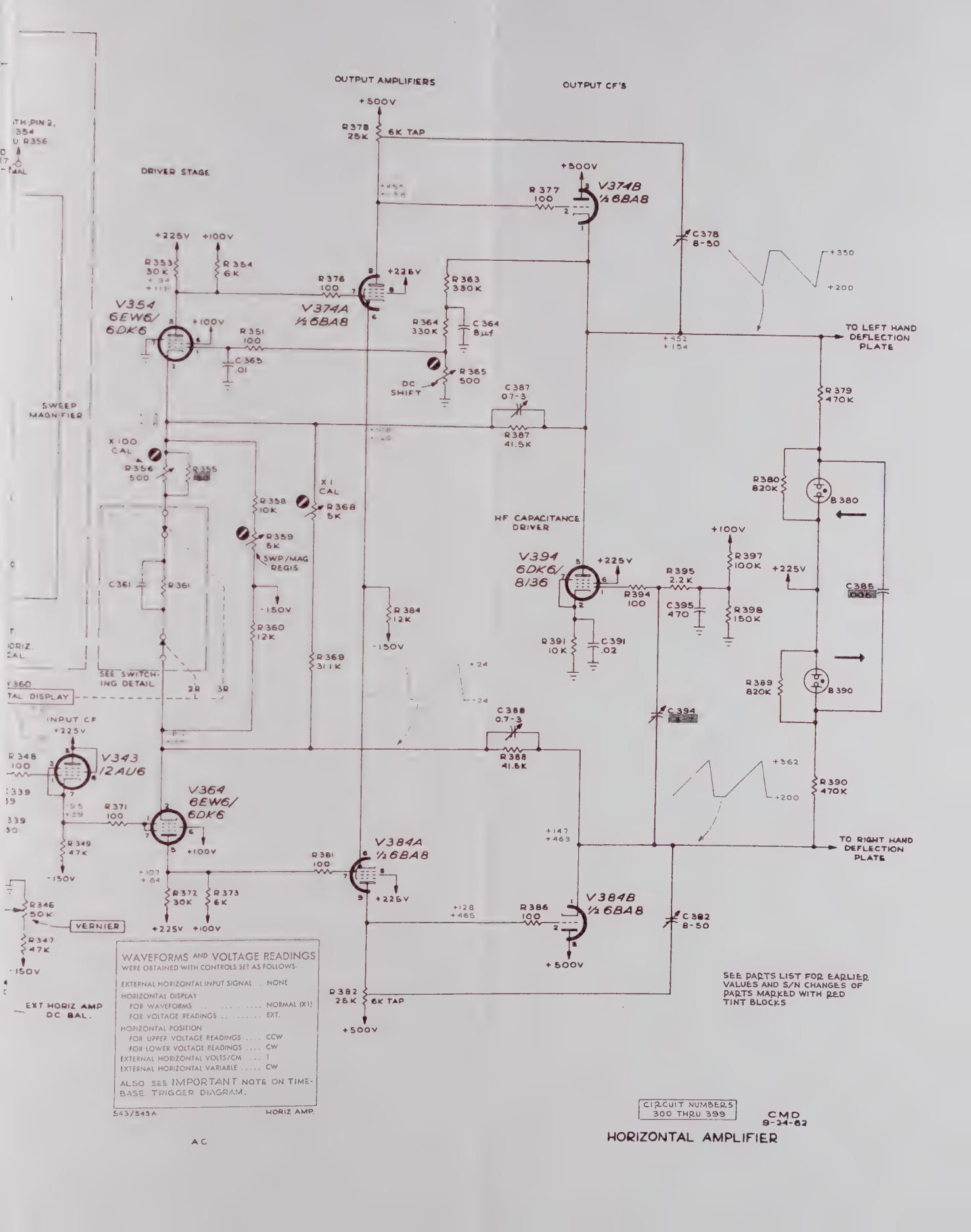


Fig. 4-6. Simplified Type 543/543A Horizontal Amplifier.



TYPE 543/543A OSCILLOSCOPE


OUTPUT AMPLIFIERS
OUTPUT CF'S
+500V
R378 25K
6K TAP
DRIVER STAGE
+500V
R377 100
V374B ½6BA8
C378 8-50
+350
+200
+225V
+100V
R353 30K
R354 6K
R376 100
+225V
R363 330K
V354 6EW6/ 6DK6
V374A ½6BA8
R364 330K
C364 8µf
TO LEFT HAND DEFLECTION PLATE
+100V
R351 100
C365 .01
DC SHIFT
R365 500
C387 0.7-3
R387 41.5K
R379 470K
SWEEP MAGNIFIER
X100 CAL
R356 500
R355
R358 10K
X1 CAL
R368 5K
R359 5K
SWP/MAG REGIS
HF CAPACITANCE DRIVER
R380 820K
B380
+100V
V394 6DK6/ 8136
+225V
R395 2.2K
R397 100K
+225V
C386
R394 100
C395 470
R398 150K
C361
R361
-150V
R360 12K
R384 12K
-150V
R391 10K
C391 .02
R369 311K
SEE SWITCHING DETAIL
2R
3R
R389 820K
B390
C394
INPUT CF
+225V
C388 0.7-3
R388 41.5K
R348 100
V343 12AU6
+362
+200
V364 6EW6/ 6DK6
R390 470K
R371 100
R349 47K
-150V
V384A ½6BA8
R381 100
+147
+463
TO RIGHT HAND DEFLECTION PLATE
+225V
+100V
R372 30K
R373 6K
+225V
+128
+465
R386 100
V384B ½6BA8
C382 8-50
R346 50K
VERNIER
R347 47K
-150V
+500V
R382 25K
6K TAP
+500V
EXT HORIZ AMP DC BAL.
SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED WITH RED TINT BLOCKS
WAVEFORMS AND VOLTAGE READINGS
WERE OBTAINED WITH CONTROLS SET AS FOLLOWS:
EXTERNAL HORIZONTAL INPUT SIGNAL . NONE
HORIZONTAL DISPLAY
FOR WAVEFORMS . . . . . NORMAL (X1)
FOR VOLTAGE READINGS . . . . . EXT.
HORIZONTAL POSITION
FOR UPPER VOLTAGE READINGS . . . . CCW
FOR LOWER VOLTAGE READINGS . . . . CW
EXTERNAL HORIZONTAL VOLTS/CM . . . 1
EXTERNAL HORIZONTAL VARIABLE . . . . . CW
ALSO SEE IMPORTANT NOTE ON TIME-BASE TRIGGER DIAGRAM.
543/543A
HORIZ AMP.
CIRCUIT NUMBERS 300 THRU 399
CMD 9-24-62
HORIZONTAL AMPLIFIER
AC

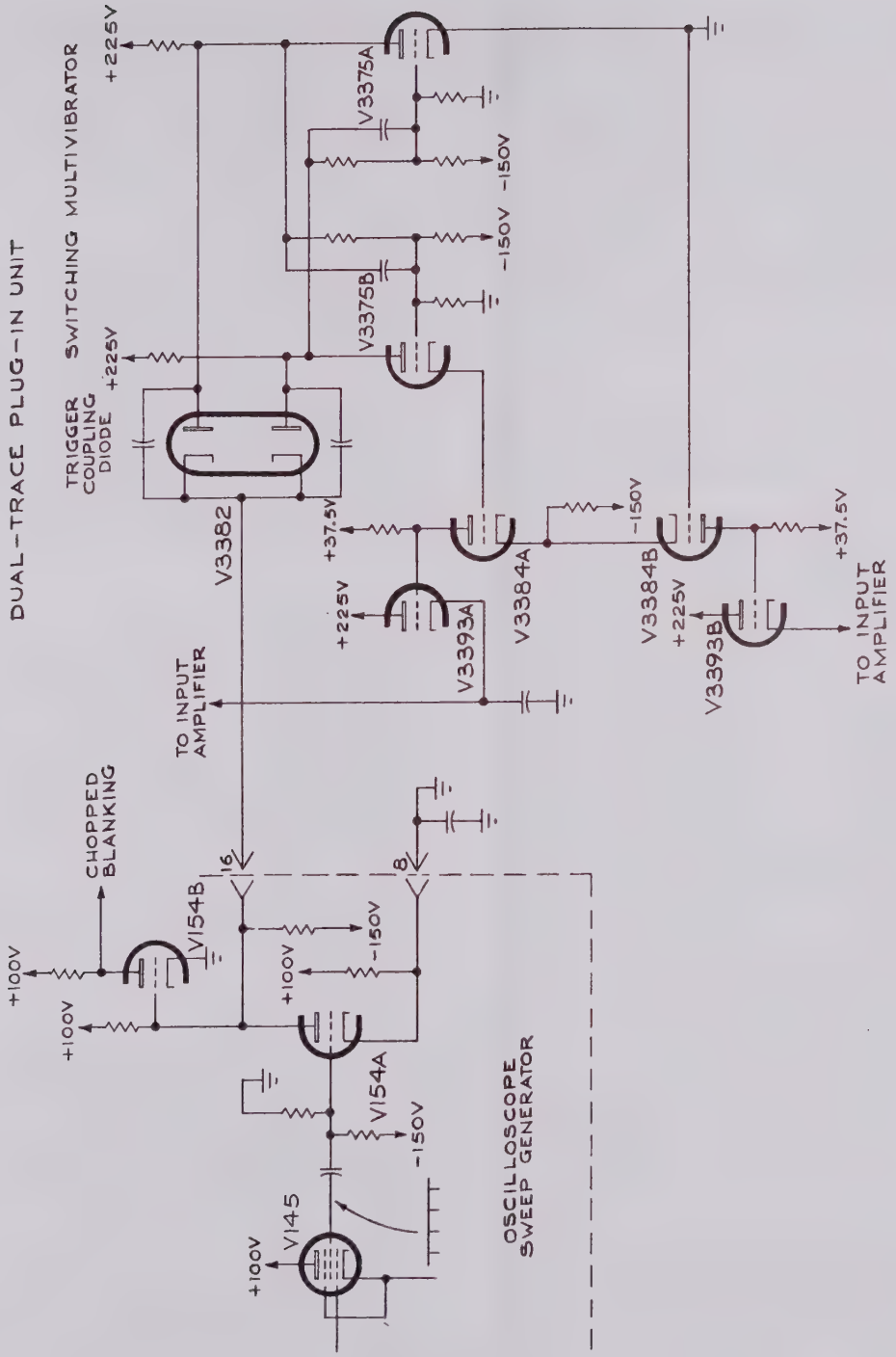


Fig. 4-7. Simplified Dual-Trace Operation.

Input CF V343. The attenuation of the divider can be altered slightly by the adjustment of R342 (labeled X10 CAL. on the circuit diagram). The small time-constant network C339-R339 improves the start of the waveform at the faster sweep speeds. The two positioning controls, HORIZONTAL POSITION R340 and VERNIER R346, affect the beam positioning by altering the dc level at the grid of V343. The voltage and resistance values in the positioning circuits are such that the VERNIER can move the spot about 1 centimeter while the HORIZONTAL POSITION control can move the spot about 10 centimeters when the HORIZONTAL DISPLAY switch is in the NORMAL position. Because of their low impedance, an adjustment of the positioning controls does not alter the attenuation of the divider network.

Input Amplifier

The Input Amplifier V354-V364 is a cathode-coupled phase inverter; the positive-going sawtooth at the grid of V364 is converted to a push-pull sawtooth in the plate circuit.

The impedance network connected between the two cathode circuits plays an important role in determining the amount of negative feedback applied to the Input Amplifier. Two of the components in this network, R361 and C361, have their value selected by the HORIZONTAL DISPLAY switch. The negative feedback which comes from the cathodes of the Output CF stage is applied through a frequency-compensated divider consisting of R387-C387 on one side and R388-C388 on the other, and the impedance connected between the cathodes of the Input Amplifier. The smaller the impedance connected between the two cathodes the greater the drop across the series components and the less the amount of feedback applied to the Input Amplifier. Details of the R361-C361 network are shown in the switch layout in the upper left corner of the Horizontal Amplifier diagram. In the X100 SWEEP MAGNIFIED position of the HORIZONTAL DISPLAY switch, R361 and C361 are replaced with a bare bus wire; this decreases the negative feedback and increases the gain of the stage 100 times over that of the NORMAL (X1) position of the switch. The X100 Cal. control R356 is adjusted to calibrate the maximum gain of the stage; the minimum gain (HORIZONTAL DISPLAY switch in the NORMAL (X1) position) is adjusted with the X1 Cal. control R368.

For dc and extremely low frequencies, a small amount of positive feedback is coupled from the cathode of V374B to the grid of V354. The DC Shift control R365 is adjusted so that the time constant of the feedback network is equal to the time constant of the slump distortion in the tubes.

The Swp./Mag. Regis. control R359 is adjusted to preserve the dc balance of the amplifier as the degeneration networks in the cathode circuit of the Input Amplifier are changed. This will insure that the portion of the trace in the exact center of the crt, when the HORIZONTAL DISPLAY switch is in the NORMAL position, will be expanded symmetrically about the center when the switch is moved to any of the SWEEP MAGNIFIED positions.

Two MAGNIFIER neon glow lamps are located on the front panel immediately below the HORIZONTAL DISPLAY switch; circuitry for the lamps is shown in the switch-detail section of the Horizontal Amplifier diagram. The MAGNIFIER ON lamp glows whenever the HORIZONTAL DISPLAY switch is in any of the SWEEP MAGNIFIED positions. The MAGNIFIER UNCALIBRATED lamp is connected to glow whenever the sweep speeds exceeds the maximum calibrated rate of .02 μsec/cm. This lamp will not glow so long as the setting of the TIME/CM switch, divided by the magnification factor, is not less than .02 μsec.

Output Stage

The Output Amplifier stage V374A-V384A operates as a conventional push-pull, plate loaded amplifier. The cathode followers V374B-V384B provide a high-impedance, low-capacitance load to help maintain the gain of the stage constant over the sweep range of the instrument. The cathode followers also provide the necessary low-impedance output to drive the capacitance of the horizontal deflection plates. Bootstrap capacitors C378 and C382 improve the response at the faster sweep rates by supplying additional current from the Output C.F. stage to charge and discharge the stray capacitance in the plate circuit of the Output Amplifier.

Capacitance Driver

At the faster sweep rates the current through the Output C.F. tubes is too small to discharge the capacitance of the horizontal deflection plates and their associated wiring at the required rate. Additional current for this purpose is provided by the gated pentode V394 connected in the cathode-return circuit of V374B. This permits the cathode of V374B, the negative-sawtooth cathode follower, to run down at the required rate. A similar current boost is not required for V384B since this tube is the positive-sawtooth cathode follower and the cathode runs down during the retrace.

Because the plate current of a pentode is fairly constant over a large range of plate voltage, the cathode current of V374B will remain nearly constant even though its cathode falls about 150 volts during the trace portion of the negative sweep waveform.

The additional current required for faster sweep rates is obtained by applying a positive flat-topped pulse to the grid of the pentode V394 during the period of the sweep. This pulse is derived by differentiating the positive-going sawtooth, available at the cathode of V384B, in C394 and the resistance in the grid circuit of V394. The amplitude of this pulse is proportional to the slope of the sawtooth, and thus proportional to the sweep speed.

External Sweep

A front-panel binding post labeled EXTERNAL HORIZ. IN couples an externally-derived signal to the Horizontal Amplifier circuit when the HORIZONTAL DISPLAY switch is in the EXT. position. A preamplifier stage, V324 is also connected onto the circuit. The setting of the EXTERNAL HORIZONTAL VOLTS/CM switch determines whether the signal is directly coupled to the grid circuit of V324A, or

whether one of two frequency-compensated attenuators is connected in the signal path. For all positions of this switch the input impedance is 1 megohm shunted by approximately 45 $\mu\mu$f.

The External-Horizontal Preamplifier V324 operates as a cathode-coupled amplifier. V324A is the cathode-follower and V324B is the grounded-grid stage. The VARIABLE control R325 provides a means for adjusting the gain over a 10 to 1 range. The Ext. Horiz. Amp. DC. Bal. control R334 adjusts the dc level of V324B so that its cathode will be at the same voltage as the cathode of V324A when no signal is applied to the grid of V324A. With the cathodes at the same voltage there will be no current through the VARIABLE control R325. By this arrangement an adjustment of the VARIABLE gain control will not change the dc level at the plate of V324B and therefore will not affect the positioning of the beam.

The gain of the Horizontal Amplifier, when connected for external operation, is calibrated by means of the Ext. Horiz. Amp. Cal. control R361M, shown in the Switch Details section of the circuit diagram. This control is adjusted so the horizontal deflection will agree with the setting of the EXTERNAL HORIZONTAL VOLTS/CM switch when the VARIABLE control is turned full right to the CALIBRATED position.

LOW VOLTAGE POWER SUPPLY

General

General circuit design of the low voltage power supply is nearly identical in the Type 543A to that found in the Type 543. However, circuit numbers assigned to individual components are considerably different for the two instruments. Therefore, in the Low-Voltage Power Supply description to follow, descriptions of circuitry for the Type 543 and Type 543A will be given separately for purposes of greater simplicity and ease of understanding. Refer to the section which applies to your type of instrument in each case.

Power Transformer

Plate and filament power for the tubes in the Type 543/543A is furnished by a single power transformer, T700 in Type 543, T601 in Type 543A. The primary has two equal windings which may be connected in parallel for 117-volt operation, or in series for 234-volt operation. The power supply will maintain regulation over line voltage ranges of 105 and 125 volts, or 210 to 250 volts, rms, 50-60 cycles. Bridge rectifiers are employed for the five separate, full-wave, power supplies. The five supplies furnish regulated output voltages of —150, +100, +225, +350 and +500 volts.

Type 543 —150 Volt Supply

In Type 543 instruments, reference voltage for the —150 volt supply is furnished by a gas diode voltage-reference tube V710. This tube, which has a constant voltage drop, establishes a fixed potential of about —87 volts at the grid of V712A, one-half of the difference amplifier. The grid voltage for the other half of the difference amplifier V712B, is obtained from a divider consisting of R715, R716, and R718. The —150 ADJ. control R716 determines the percentage of total voltage that appears at the grid of V712B and thus determines the total voltage across the divider. This control is adjusted so that the output voltage is exactly —150 volts.

If line-voltage or load fluctuations tend to change the output voltage, an error signal exists between the two grids of the difference amplifier. The error signal is amplified in V712B and V700 and applied to the grids of the series tubes V725, V726, and V727. The resulting change in voltage at the plates of the series tubes, which will be in a direction to compensate for any change in output voltage, is coupled through the rectifiers to the output to keep this voltage constant. Capacitors C707 and C717 improve the ac gain of the feedback loop to increase the response of the regulator circuit to sudden changes in output voltage.

A small amount of unregulated bus ripple is coupled to the screen of V700 through R728. The phase of the amplified ripple voltage at the plate of V700 is such as to cancel most of the ripple on the —150-volt bus.

Type 543A —150 Volt Supply

In the Type 543A, reference voltage for the —150 volt supply is furnished by a gas diode voltage-reference tube V609. This tube, which has a constant voltage drop, establishes a fixed potential of about —87 volts at the grid of V624A, one-half of a difference amplifier. The grid voltage for the other half of the difference amplifier, V624B, is obtained from a divider consisting of R616, R617, and R618. The —150 ADJ. control R616 determines the percentage of total voltage that appears at the grid of V624B and thus determines the total voltage across the divider. This control is adjusted so that the output voltage is exactly —150 volts.

If line-voltage or load fluctuations tend to change the output voltage, an error signal exists between the two grids of the difference amplifier. The error signal is amplified in V624B and V634 and applied to the grids of the series tubes V627, V637 and V647. The resulting changes in voltage at the plates of the series tubes, which will be in a direction to compensate for any change in output voltage, is coupled through the rectifiers to the output to keep this voltage constant. Capacitors C617 and C628 improve the ac gain of the feedback loop to increase the response of the regulator circuit to sudden changes in output voltage.

A small amount of unregulated bus ripple is coupled to the screen of V634 through R637. The phase of the amplified ripple voltage at the plate of V634 is such as to cancel most of the ripple on the —150 volt bus.

Type 543 +100 Volt Supply

In Type 543, the +100-Volt Supply is regulated by comparing to ground (the cathode of V742) the voltage of a

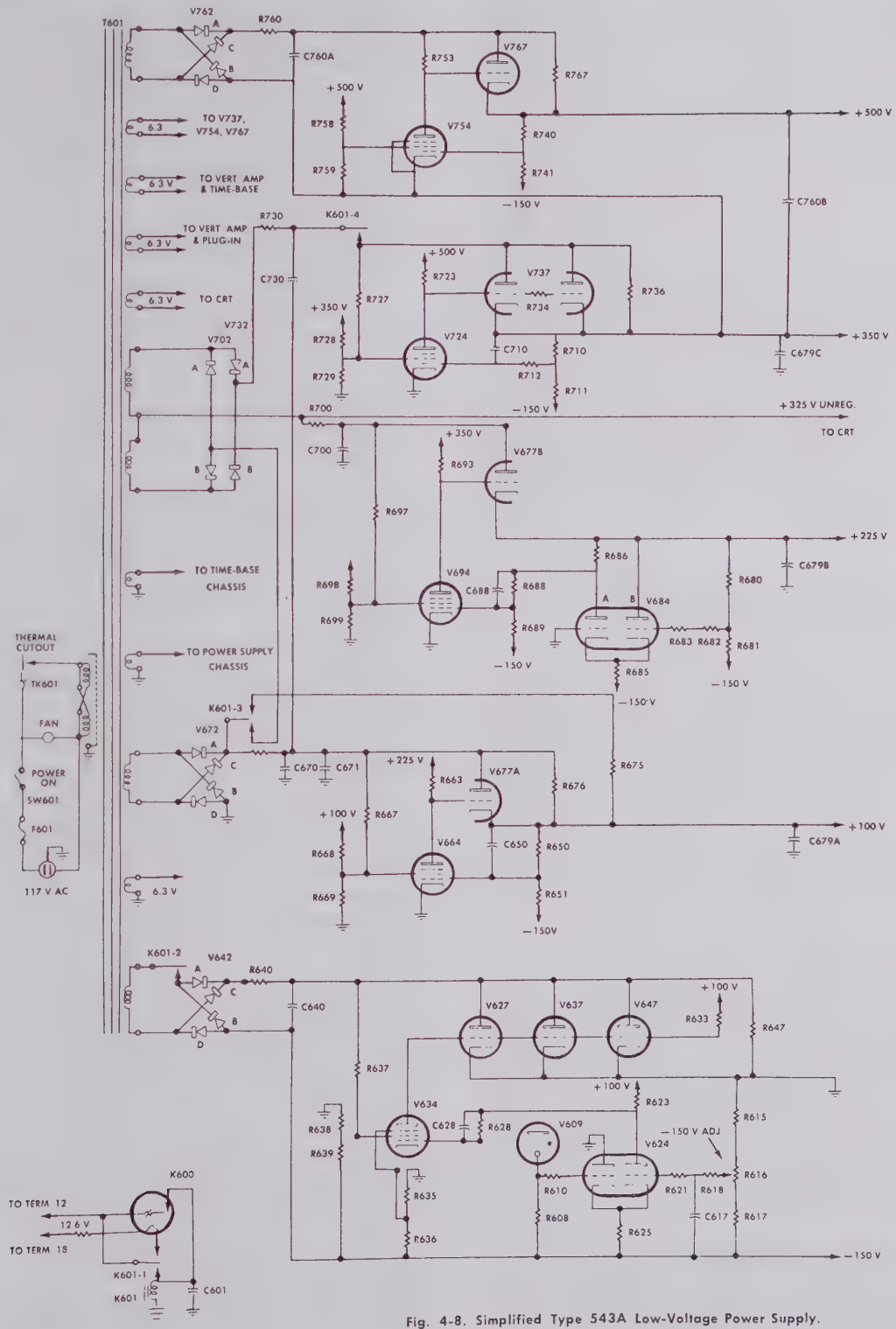


Fig. 4-8. Simplified Type 543A Low-Voltage Power Supply.

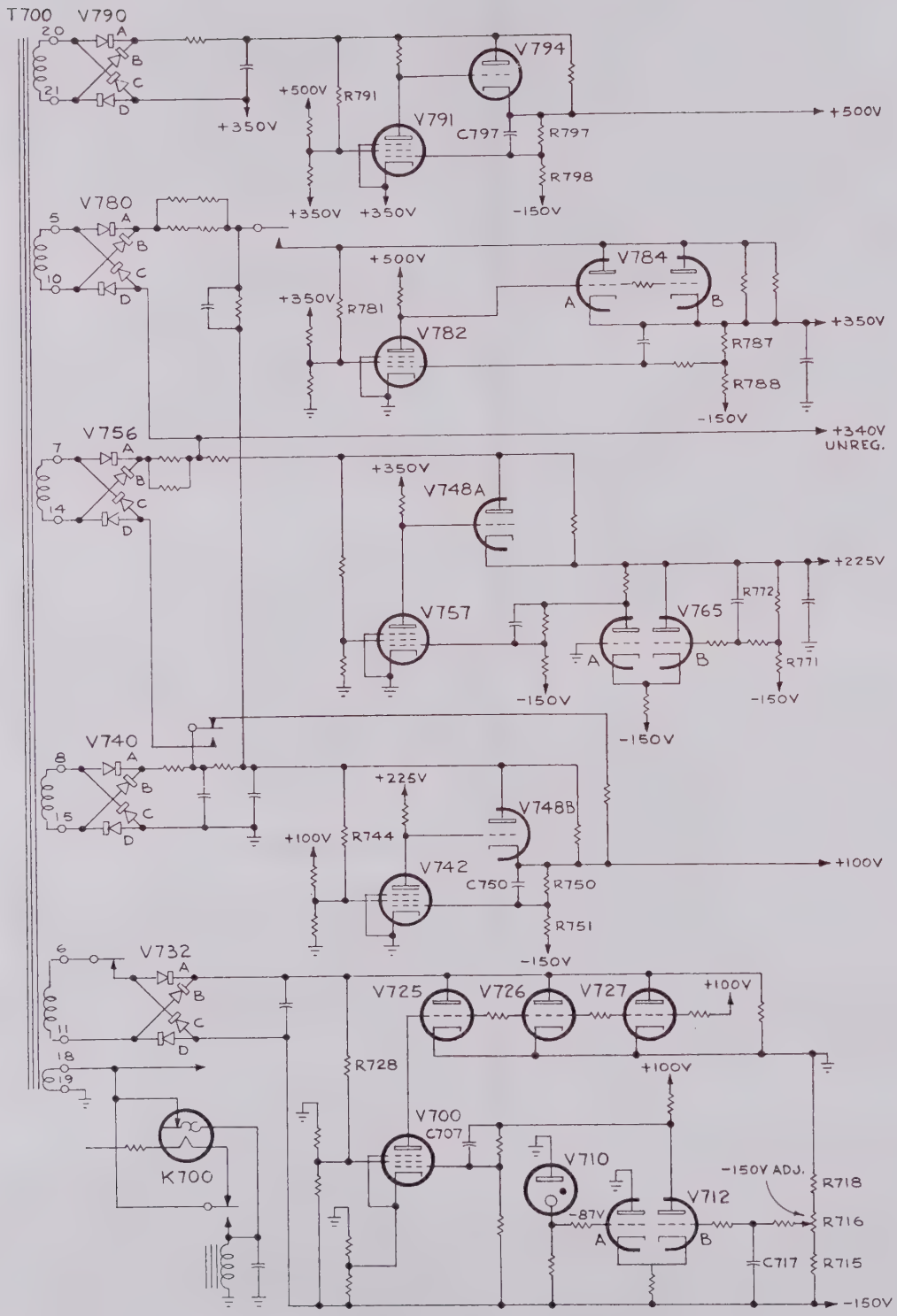


Fig. 4-9. Simplified Type 543 Low-Voltage Power Supply.

point near ground potential obtained from the divider R750-R751 connected between the +100-volt bus and the regulated —150 volt supply. Any error voltage that exists is amplified and inverted in polarity by V742 and coupled through the cathode follower V748B to the output to prevent the output voltage from changing. Capacitor C750 improves the ac gain of this circuit.

A small sample of the unregulated bus ripple appears at the screen of V742 through R744. This produces a ripple component at the grid of the cathode follower V748B that is opposite in polarity to the ripple at the plate; this tends to cancel the ripple at the cathode and hence on the +100 volt bus. This same circuit also improves the regulation in the presence of line-voltage variations.

Type 543A +100-Volt Supply

In the Type 543A, the 100-volt supply is regulated by comparing to ground (the cathode of V664) the voltage of a point near ground potential obtained from the divider R650-R651 connected between the +100-volt bus and the regulated —150 volt supply. Any error voltage that exists is amplified and inverted in polarity by V664 and coupled through the cathode follower V677A that is opposite in polarity to the ripple at the plate; this tends to cancel the ripple at the cathode and hence on the +100-volt bus. This same circuit also improves the regulation in the presence of line-voltage variations.

Type 543 +225 Volt Supply

Rectified voltage from terminals 7 and 14 of the power transformer is added to the voltage supplying the +100-volt regulator to furnish power for the +225-volt regulator. This supply is regulated by comparing to ground (the grid of V765A) the voltage of a point near ground obtained from the divider R772-R771 connected between the +225-volt bus and the regulated —150-volt supply. Any error voltage that exists between the grids of the difference amplifier (V765) is amplified in both V765 and V757, and coupled through the cathode follower V748A to the +225-volt bus. The change in voltage at the cathode of V748A, due to the regulator action, will be opposite in polarity to the original error signal and will thus tend to keep the output constant. This supply also furnishes an unregulated output of about +340 volts for the oscillator in the crt high-voltage supply. It is unnecessary to regulate this voltage as the crt supply has its own regulator circuits.

Type 543A +225 Volt Supply

In Type 543A, rectified voltage from terminals 10 to 14 of the power transformer is added to the voltage supplying the +100 volt regulator to furnish power for the +225 volt regulator. This supply is regulated by comparing to ground (the grid of V684A) the voltage of a point near ground obtained from the divider R680-R681 connected between the +225 volt bus and the regulated —150 volt supply. Any error voltage that exists between the grids of the difference amplifier (V684) is amplified in both V684 and V694, and coupled through the cathode follower V677B to the +225 volt bus. The change in voltage at the cathode of V677B, due to the regulator action, will be opposite in polarity to the original error signal and will thus tend to keep the output constant. This supply also furnishes an unregulated output of about +325 volts for the oscillator in the crt high-voltage supply. It is unnecessary to regulate this voltage as the crt supply has its own regulator circuits.

Type 543 +350-Volt Supply

In the Type 543, rectified voltage from terminals 5 and 10 of T700 is added to voltage supplying the +225 volt regulator to furnish power for the +350 volt regulator. This supply is regulated by comparing to ground the voltage of a point near ground obtained from the divider R787-R788 connected between the +350 volt bus and the regulated —150 volt supply. The operation of the regulator circuit is the same as that described for the +100 volt supply.

Type 543A +350-Volt Supply

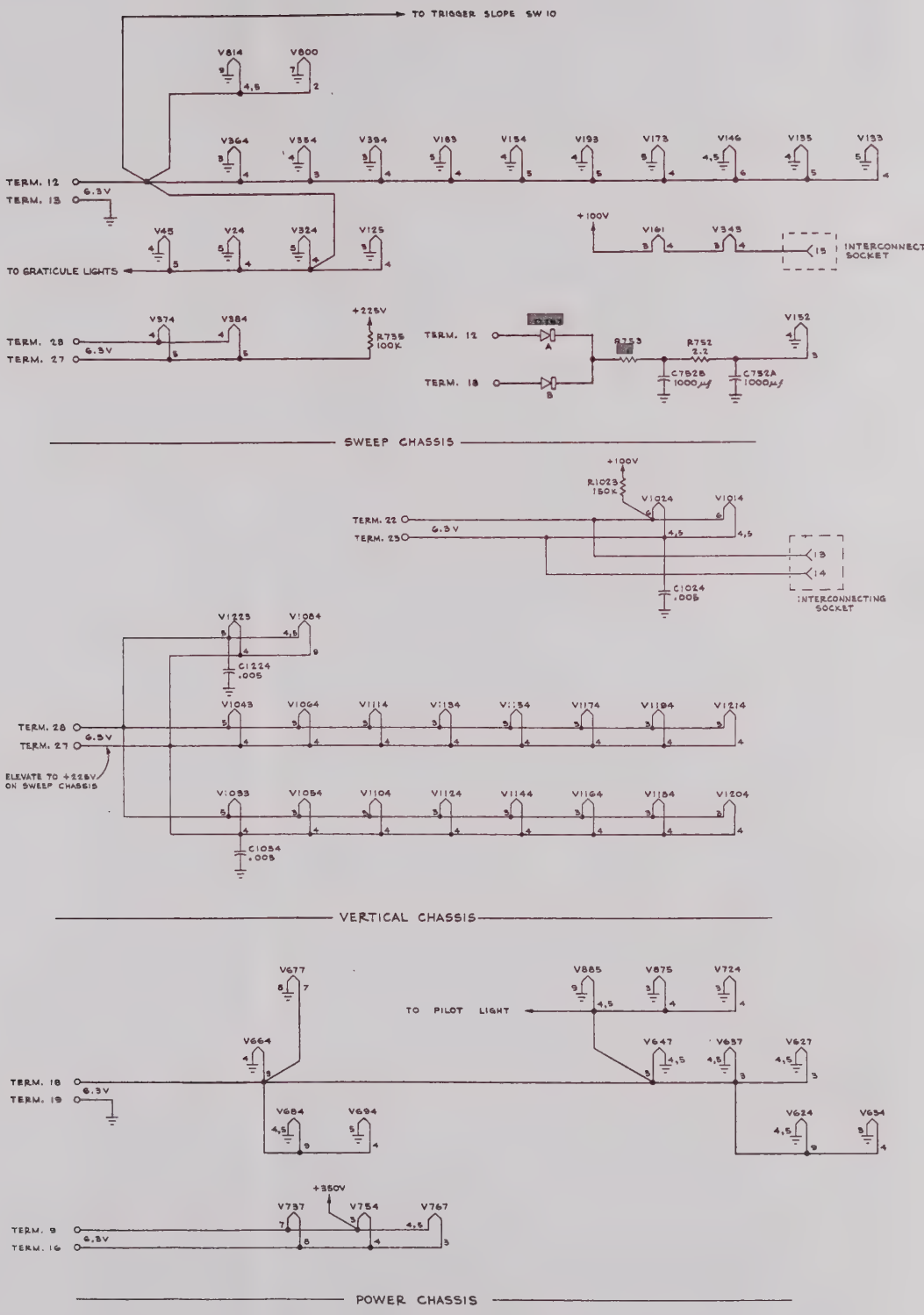
In the Type 543A, rectified voltage from terminals 5 and 14 of T601 is added to voltage supplying the +100 volt regulator to furnish power for the +350 volt regulator. This supply is regulated by comparing to ground the voltage of a point near ground obtained from the divider R710-R711 that is connected between the +350 volt bus and the regulated —150 volt supply. The operation of the regulated circuit is the same as that described for the +100 volt supply.

Type 543 +500 Volt Supply

In Type 543, rectified voltage from terminals 20 and 21 of T700 is added to the regulated side of the +350 volt supply to furnish power for the +500 volt regulator. This supply is regulated by comparing to the regulated +350 volts the voltage of a point near +350 obtained from the divider R797-R798 connected between the +500 volt bus and the regulated —150 volt supply. The regulator action of this circuit is the same as that described for the +100 volt supply.

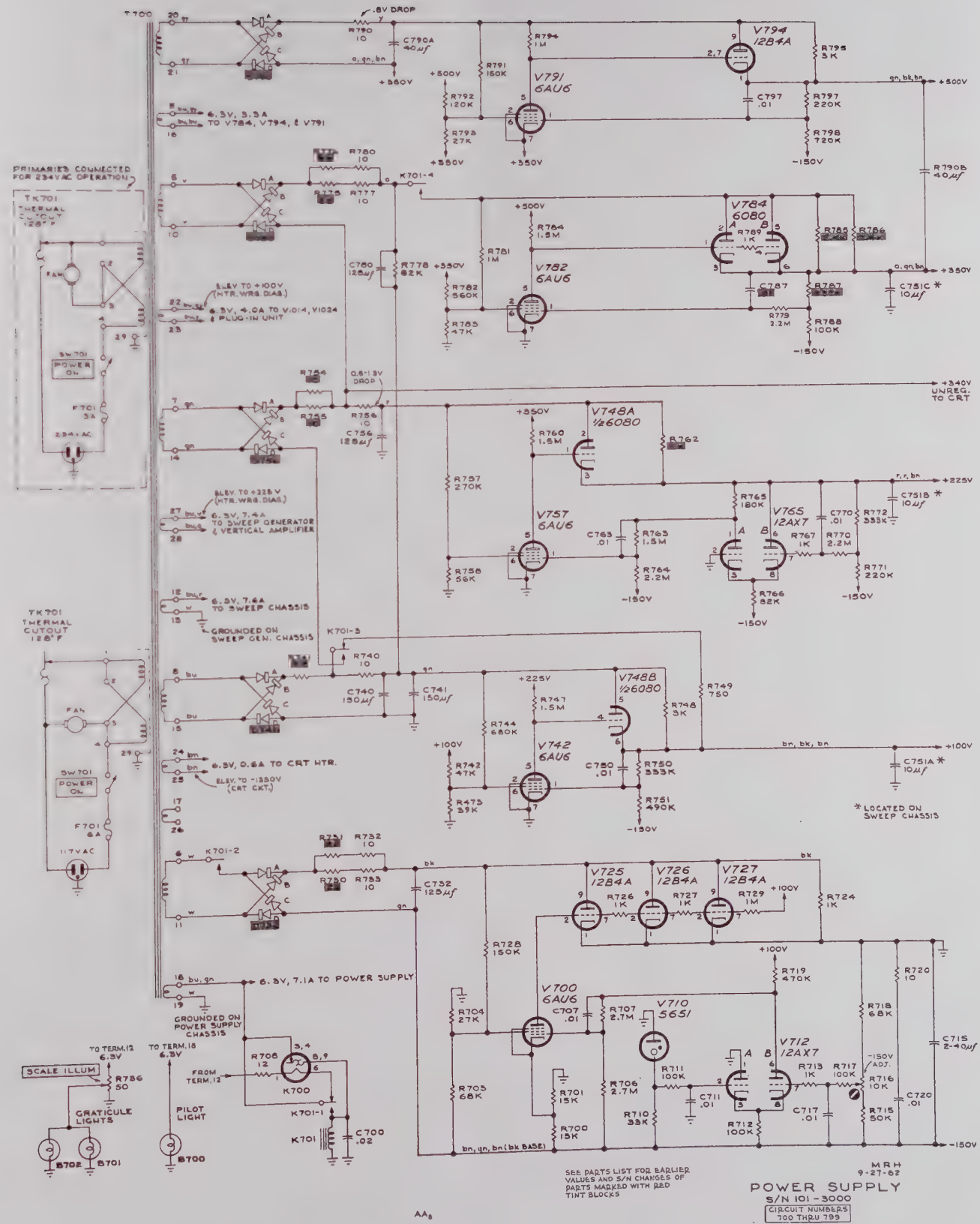
Type 543A +500 Volt Supply

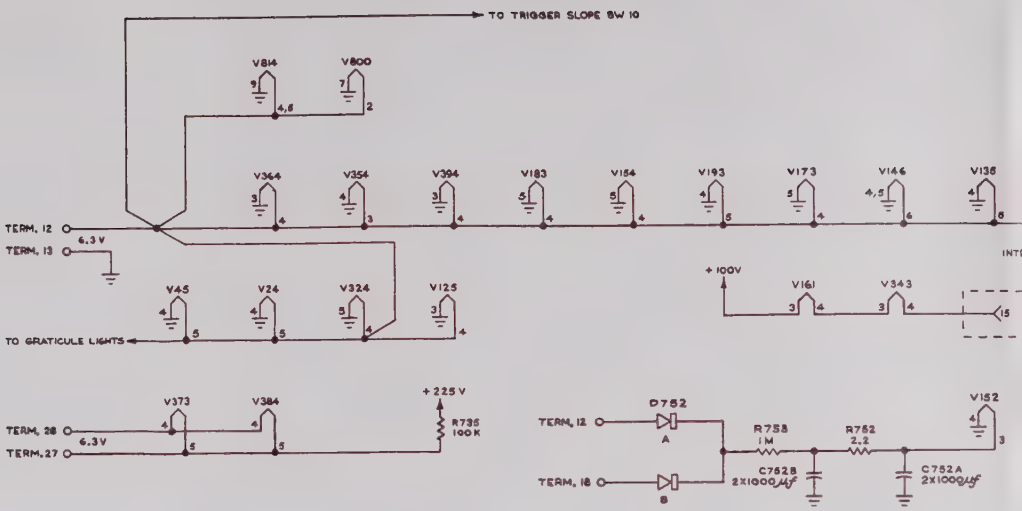
In Type 543A, rectified voltage from terminals 20 and 21 of T601 is added to the regulated side of the +350 volt supply to furnish power for the +500 volt regulator. This supply is regulated by comparing to the regulated +350 volts the voltage of a point near +350 obtained from the divider R740-R741 connected between the +500 volt bus and the regulated —150 volt supply. The regulator action of this circuit is the same as that described for the +100-volt supply.



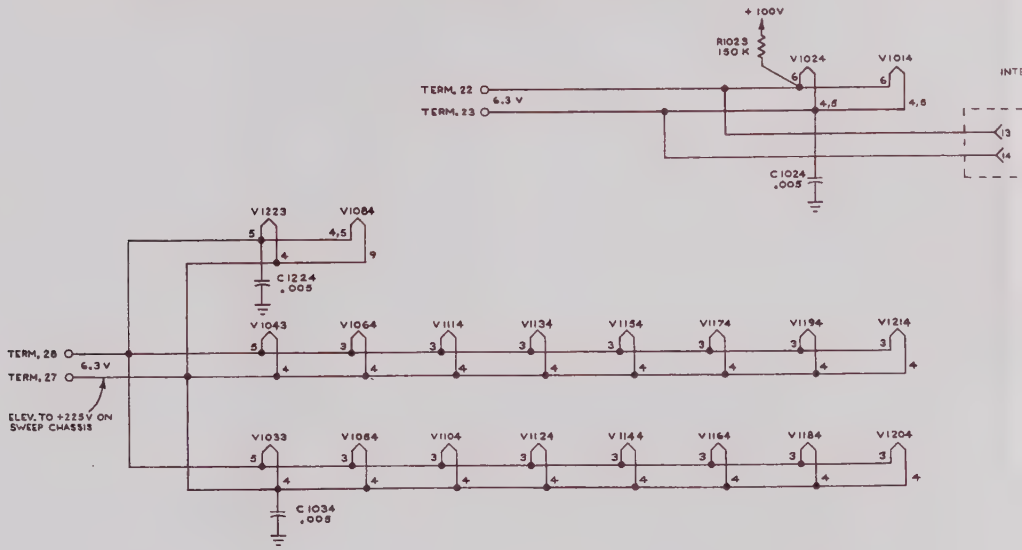
TYPE 543 OSCILLOSCOPE

HEATER WIRING DIAGRAM

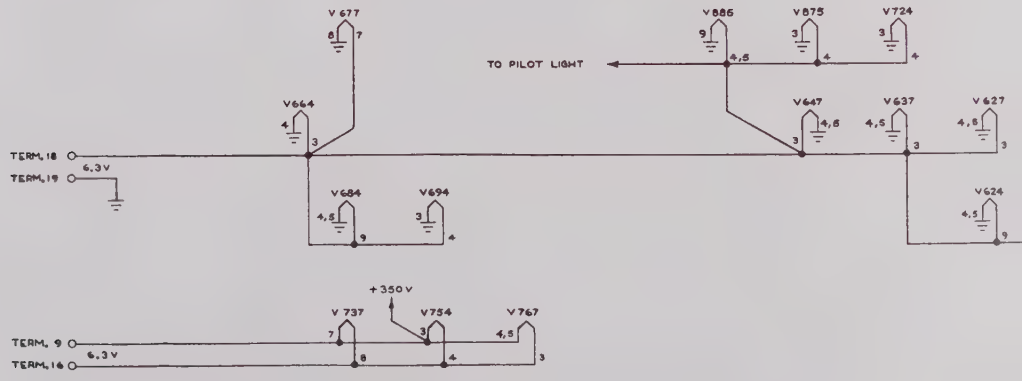

T700
.8V DROP
R790 10
C790A 40μf
V794 12B4A
R794 1M
R795 5K
V791 6AU6
R791 150K
R792 120K
R793 27K
+500V
+350V
-150V
R797 .01
R797 220K
R798 720K
R790B 40μf
6.3V, 3.3A TO V784, V794, & V791
PRIMARIES CONNECTED FOR 234 VAC OPERATION
TK701 THERMAL CUTOUT 125° F
R780 10
R775 R777 10
K701-4
V784 6080
R784 1.5M
R789 1K
R785 R786
R781 1M
V782 6AU6
R782 560K
R783 47K
C780 125μf
R778 82K
R787
R779 2.2M
R788 100K
C751C * 10μf
ELEV. TO +100V (HTR. WRG. DIAG.)
6.3V, 4.0A TO V.014, V1024 & PLUG-IN UNIT
SW 701 POWER ON
F701 3A
234 VAC
FAN
R784
0.6-1.3V DROP
R785
R756 10
C756 125μf
V748A 1/26080
R760 1.5M
R762
R757 270K
R758 56K
V757 6AU6
R765 180K
V765 12AX7
C763 .01
R763 1.5M
R764 2.2M
C770 .01
R772 333K
R767 1K
R770 2.2M
R771 220K
R766 82K
C751B * 10μf
+340V UNREG. TO CRT
+225V
ELEV. TO +225 V (HTR. WRG. DIAG.)
6.3V, 7.4A TO SWEEP GENERATOR & VERTICAL AMPLIFIER
6.3V, 7.4A TO SWEEP CHASSIS
GROUNDED ON SWEEP GEN. CHASSIS
TK701 THERMAL CUTOUT 128° F
K701-3
R740 10
C740 150μf
C741 150μf
V748B 1/26080
R747 1.5M
R748 3K
R749 750
R744 680K
V742 6AU6
R742 47K
R743 39K
C750 .01
R750 333K
R751 490K
+100V
6.3V, 0.6A TO CRT HTR.
ELEV. TO -1350V (CRT CKT.)
C751A * 10μf
* LOCATED ON SWEEP CHASSIS
K701-2
R731 R732 10
R730 R733 10
C732 125μf
V725 12B4A
V726 12B4A
V727 12B4A
R726 1K
R727 1K
R729 1M
R724 1K
R728 150K
6.3V, 7.1A TO POWER SUPPLY
GROUNDED ON POWER SUPPLY CHASSIS
V700 6AU6
C707 .01
R707 2.7M
V710 5651
R704 27K
R719 470K
R720 10
R718 68K
C715 2.40μf
R703 68K
R701 15K
R700 15K
R706 2.7M
R711 100K
R710 33K
C711 .01
V712 12AX7
R713 1K
R717 100K
-150V ADJ.
R716 10K
R715 50K
C717 .01
R712 100K
C720 .01
SCALE ILLUM
R736 50
GRATICULE LIGHTS
B702
B701
TO TERM. 12 6.3V
TO TERM. 18 6.3V
FROM TERM. 12
R708 12
K700
K701-1
K701
C700 .02
PILOT LIGHT
B700
bn, gn, bn (bk BASE)
SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED WITH RED TINT BLOCKS
MRH 9-27-62
POWER SUPPLY
S/N 101 - 3000
CIRCUIT NUMBERS 700 THRU 799
AA8



SWEEP CHASSIS



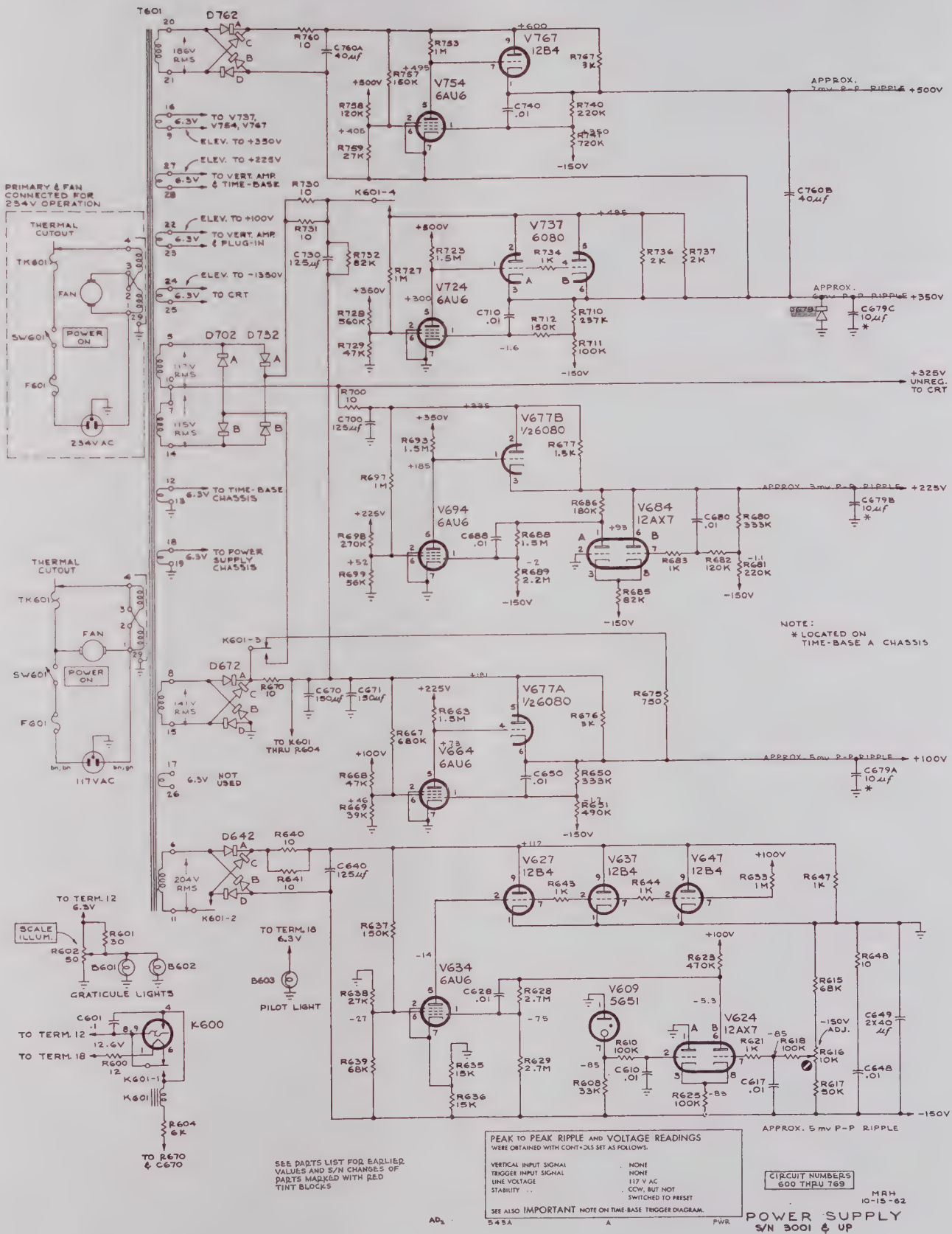
VERTICAL CHASSIS



POWER SUPPLY CHASSIS

TYPE 543A OSCILLOSCOPE

HEATER WIRING DIAGRAM


T601
D762
R760 10
C760A 40μf
186V RMS
R753 1M
V767 12B4
R767 3K
+600
+500V
R767 160K
+495
V754 6AU6
R758 120K
+405
R759 27K
C740 .01
R740 220K
R744 720K
-150V
APPROX. 7mv P-P RIPPLE +500V
C760B 40μf
6.3V TO V737, V754, V767
ELEV. TO +350V
ELEV. TO +225V
6.3V TO VERT. AMP & TIME-BASE
ELEV. TO +100V
6.3V TO VERT. AMP & PLUG-IN
ELEV. TO -1350V
6.3V TO CRT
PRIMARY & FAN CONNECTED FOR 234V OPERATION
THERMAL CUTOUT
TK601
FAN
SW601
POWER ON
F601
234VAC
R730 10
K601-4
R731 10
C730 125μf
R732 82K
+800V
R723 1.5M
V737 6080
R734 1K
R736 2K
R737 2K
+485
R727 1M
V724 6AU6
+360V
+300
R728 560K
R729 47K
C710 .01
R712 150K
R710 237K
R711 100K
-1.6
-150V
APPROX. 6mv P-P RIPPLE +350V
C679B
C679C 10μf *
D702 D732
117V RMS
115V RMS
+325V UNREG. TO CRT
R700 10
C700 125μf
+350V
+335
R693 1.5M
V677B 1/26080
R677 1.5K
+185
R697 1M
+225V
R698 270K
V694 6AU6
+52
R699 56K
C688 .01
R688 1.5M
-2
R689 2.2M
R686 180K
V684 12AX7
+93
C680 .01
R680 333K
R683 1K
R682 120K
-11
R681 220K
R685 82K
APPROX. 3mv P-P RIPPLE +225V
C679B 10μf *
6.3V TO TIME-BASE CHASSIS
6.3V TO POWER SUPPLY CHASSIS
NOTE:
* LOCATED ON TIME-BASE A CHASSIS
K601-3
D672
R670 10
141V RMS
C670 150μf
C671 150μf
TO K601 THRU R604
+225V
+181
R663 1.5M
V677A 1/26080
R676 3K
R675 750
R667 680K
+73
V664 6AU6
+100V
R668 47K
+46
R669 39K
C650 .01
R650 333K
-57
R651 490K
-150V
APPROX. 5mv P-P RIPPLE +100V
C679A 10μf *
6.3V NOT USED
D642
R640 10
R641 10
204V RMS
C640 125μf
K601-2
+112
V627 12B4
V637 12B4
V647 12B4
R643 1K
R644 1K
R633 1M
R647 1K
+100V
TO TERM. 12 6.3V
SCALE ILLUM.
R601 30
R602 50
B601
B602
GRATICULE LIGHTS
TO TERM. 18 6.3V
B603
PILOT LIGHT
R637 150K
V634 6AU6
-14
R638 27K
-27
R639 68K
C628 .01
R628 2.7M
-75
R635 15K
R636 15K
R629 2.7M
V609 5651
-5.3
R610 100K
C610 .01
-85
R608 33K
R623 470K
V624 12AX7
R621 1K
R618 100K
R616 10K
R625 100K
-83
C617 .01
R615 68K
R617 50K
R648 10
C649 2X40 μf
C648 .01
-150V ADJ.
-150V
APPROX. 5 mv P-P RIPPLE
C601
K-600
TO TERM. 12
12.6V
TO TERM. 18
R600 12
K601-1
K601
R604 6K
TO R670 & C670
SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED WITH RED TINT BLOCKS
PEAK TO PEAK RIPPLE AND VOLTAGE READINGS WERE OBTAINED WITH CONTROLS SET AS FOLLOWS:
VERTICAL INPUT SIGNAL . NONE
TRIGGER INPUT SIGNAL NONE
LINE VOLTAGE 117 V AC
STABILITY .. CCW, BUT NOT SWITCHED TO PRESET
SEE ALSO IMPORTANT NOTE ON TIME-BASE TRIGGER DIAGRAM.
CIRCUIT NUMBERS 600 THRU 769
MRH 10-15-62
AD2 543A A PWR
POWER SUPPLY S/N 3001 & UP

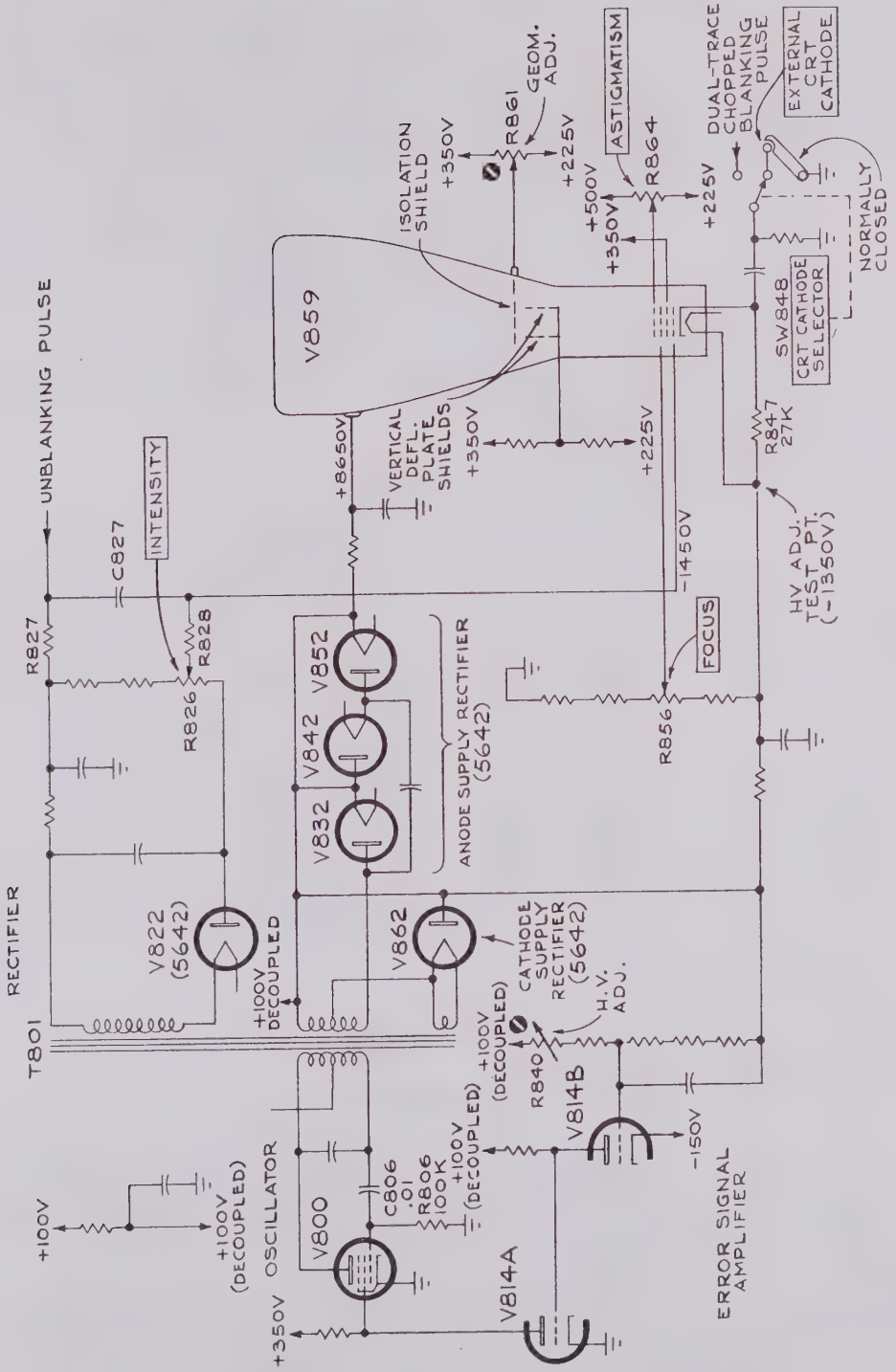


Fig. 4-10. Simplified CRT Circuit.

Time Delay

A Time-Delay relay (K700 in Type 543, K600 in Type 543A) delays the application of dc voltages to the amplifier tubes in the instrument for about 25 seconds. This delay is to allow the tube heaters time to bring the cathodes up to emission temperature before operating potentials are applied.

CRT CIRCUIT

Cathode Ray Tube Control Circuits

The INTENSITY control R831 varies the voltage at the grid of the crt to control the beam current. The FOCUS control R852 varies the voltage at the focusing ring to focus the trace. The ASTIGMATISM control R860 varies the voltage at the astigmatism anode to focus the spot in both dimensions simultaneously. The GEOM. ADJ. R842 varies the field the beam encounters as it emerges from the deflection system to control the linearity at the extremes of deflection.

The CRT CATHODE SELECTOR switch SW800 connects the cathode of the crt through C857 to either a rear panel binding post labeled EXTERNAL CRT CATHODE or to the plate of V154B in the Time-Base Generator circuit. When in the DUAL-TRACE CHOPPED BLANKING position, the cathode of the crt is connected to receive positive pulses from the Time-Base Generator circuit to blank the crt during switching while operating a dual-trace plug-in unit in the chopped mode.

When SW800 is in the EXTERNAL CRT CATHODE position, the cathode circuit of the crt is connected to the binding post mentioned previously. A bare bus bar normally connects the binding post to ground. When intensity modulation of the beam is desired, the bus bar can be removed so that the modulating signal can be coupled to the crt cathode.

High-Voltage Supply

A single 60-kc Hartley oscillator furnishes power for the three power supplies that provide accelerating potentials for the crt. The main components in the Oscillator circuit are the pentode V800 and the primary of T801 tuned by C806.

A half-wave rectifier V862 provides —1350 volts for the crt cathode. A half-wave voltage tripler circuit, V832, V842 and V852, provides +8650 volts for the post-anode accelerator. This provides a total accelerating voltage of 10,000 volts. Both supplies are tied to the +100 volt regulated supply through the decoupling filter R800-C800.

A floating half-wave rectifier V822 furnishes bias voltage (about —1450 volts) for the crt grid. This floating grid supply, independent of the cathode supply, is required in order to provide dc-coupled unblanking to the crt grid. All three supplies employ capacitor-input filters.

The —1350 volt cathode supply is regulated by comparing to the —150 volt regulated supply (the cathode of V814B) a voltage near —150 volts obtained from a tap on the divider connected between the decoupled +100 volt bus and the —1350 volt bus. The total resistance of the divider, and hence the voltage across the divider, is determined by the setting of R811 labeled HV Adj. When this control is properly adjusted, the voltage at the HV Adj. Test Point will be exactly —1350 volts.

If variations in loading should tend to change the voltage on the —1350 volt bus, an error signal will exist between the grid and cathode of V814B. The error signal will be amplified by V814B and V814A; the output of V814A varies the screen voltage of the osciliator tube V800, thereby controlling its output.

The +8650 volt supply and the negative bias supply are regulated indirectly, as the output voltage of all three supplies is proportional to the output of the Oscillator circuit.

Unblanking

As mentioned previously, dc-coupled unblanking is accomplished by employing separate power supplies for the grid and cathode of the crt. The unblanking pulses from the Time-Base Generator are transmitted to the crt grid through the cathode follower V183B and the floating grid supply.

At the faster sweep rates the stray capacitance in the circuit makes it difficult to pull up the floating supply fast enough to unblank the crt in the required time. To overcome this, an isolation network composed of C834, R834, R836, C835, C836 and R835 is employed. By this arrangement the fast leading edge of the unblanking pulse is coupled through C834 to the grid of the crt. For short-duration unblanking pulses, at the faster sweep rates, the power supply itself is not appreciably moved.

The longer unblanking pulses, at the slower sweep rates, charges the stray capacitance in the circuit through R834. This pulls up the floating supply and holds the grid at the unblanked potential for the duration of the unblanking pulse.

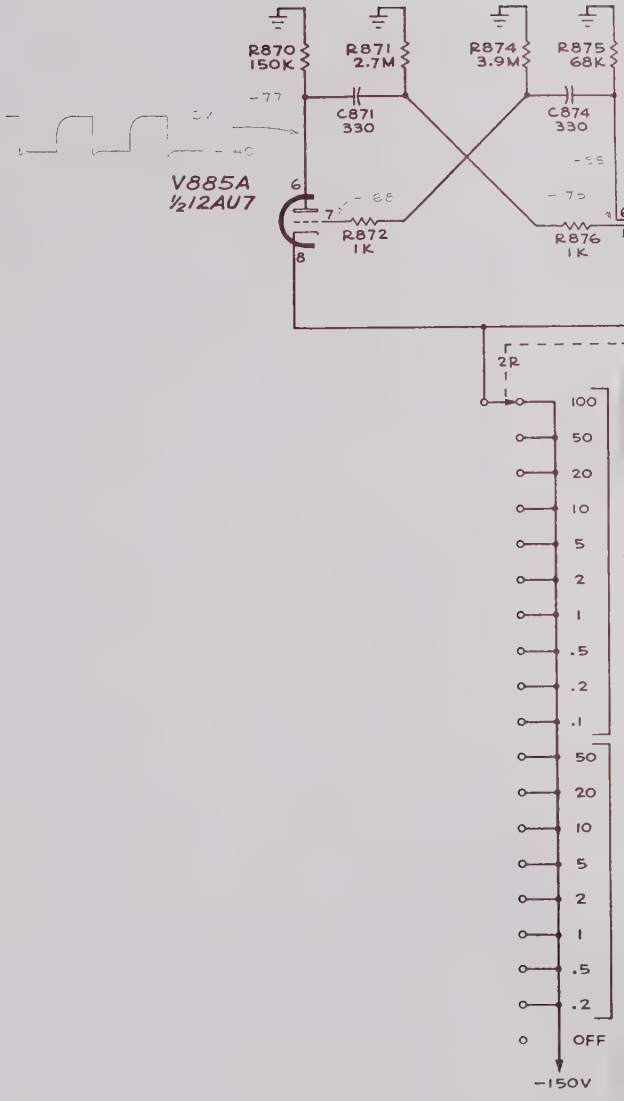
Calibrator

Type 543

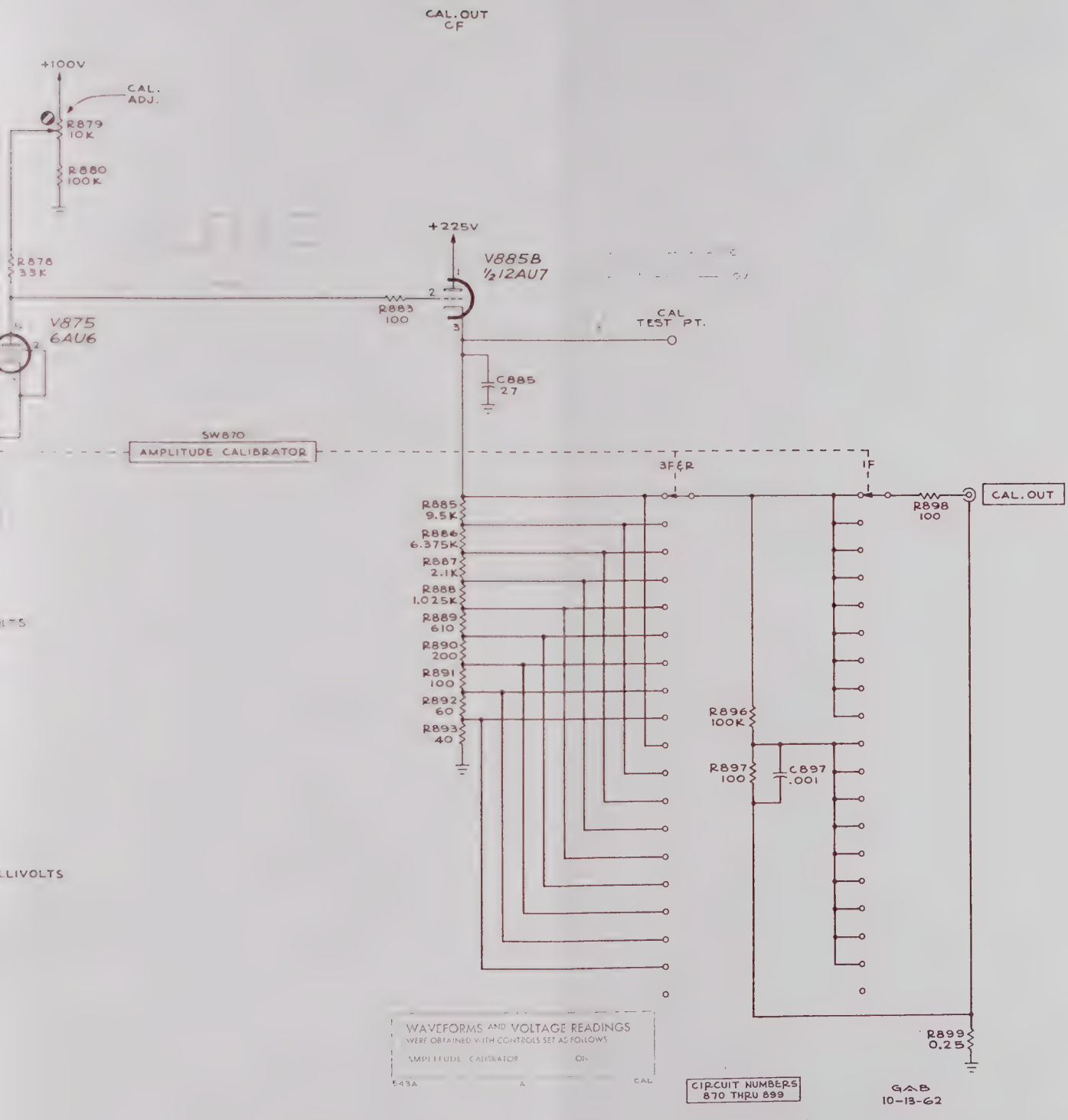
The Type 543 Calibrator is a square-wave generator whose approximately 1 kc output is available at the front panel connector labeled CAL. OUT. It consists of a multivibrator V670 connected so as to switch the cathode follower V246A between two operating states, cutoff and conduction.

During the negative portion of the Multivibrator waveform the grid of V246A is driven well below cutoff and its cathode rests at ground potential. During the positive portion of the waveform V670A is cut off and its plate rests slightly below +100 volts. The voltage at the plate of V670A, when this tube is cut off, is determined by the setting of the Cal. Adj. control R679, part of a divider connected between +100 volts and ground.

CALIBRATOR
MULTIVIBRATOR

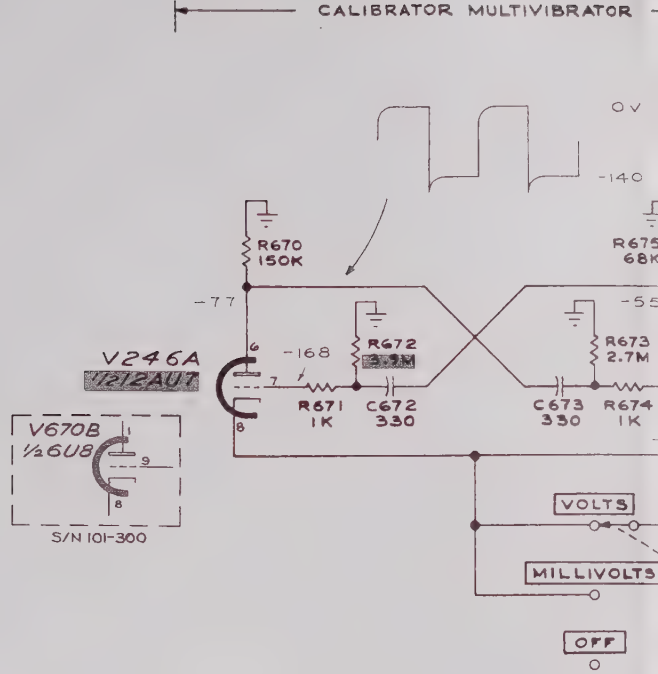


TYPE 543A OSCILLOSCOPE



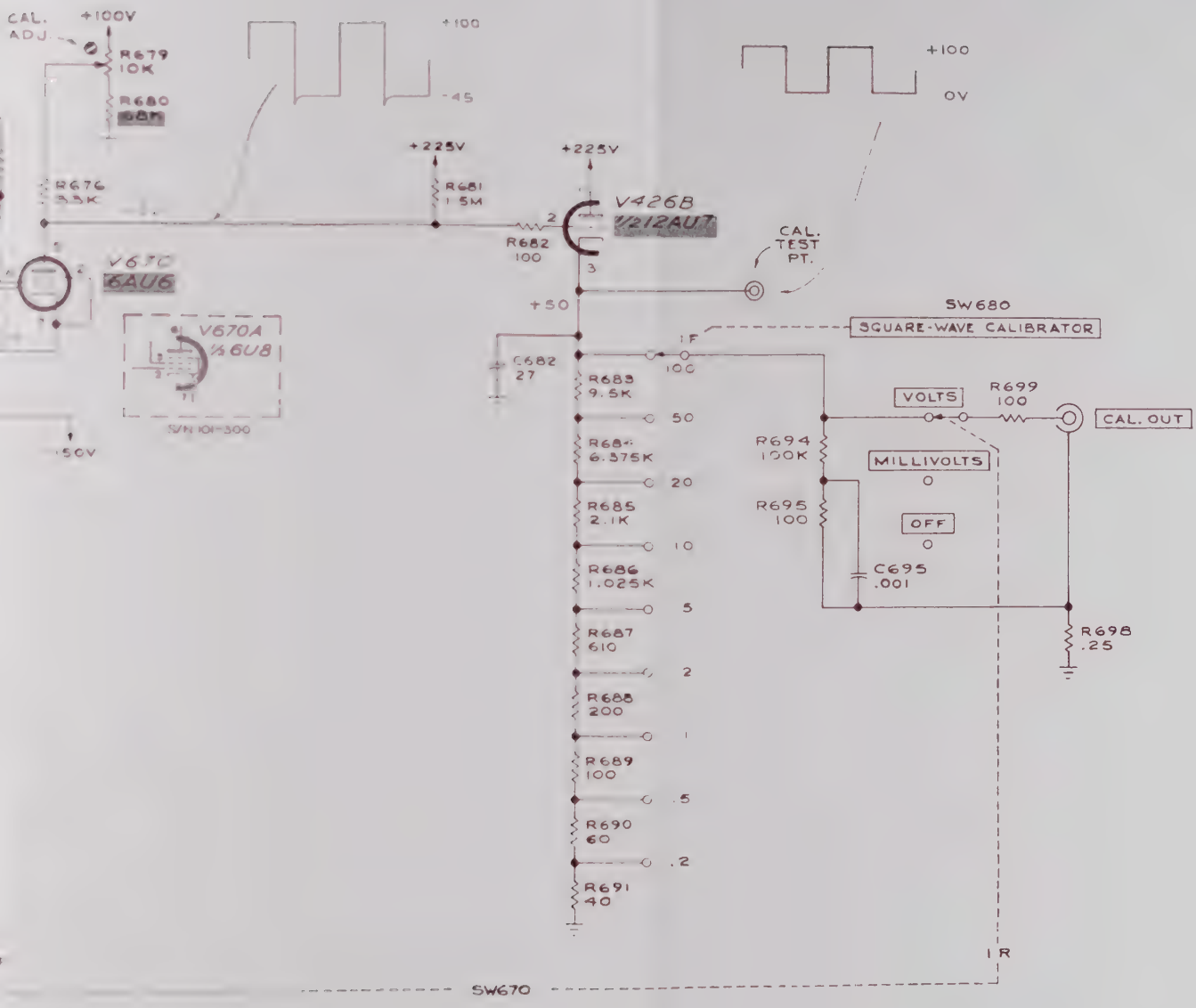
AA1

CALIBRATOR
S/N 3001 & UP



TYPE 543 OSCILLOSCOPE

CALIBRATOR C.F.



WAVEFORMS AND VOLTAGE READINGS WERE OBTAINED WITH CONTROLS SET AS FOLLOWS:
SQUARE-WAVE CALIBRATOR . . . . . ON

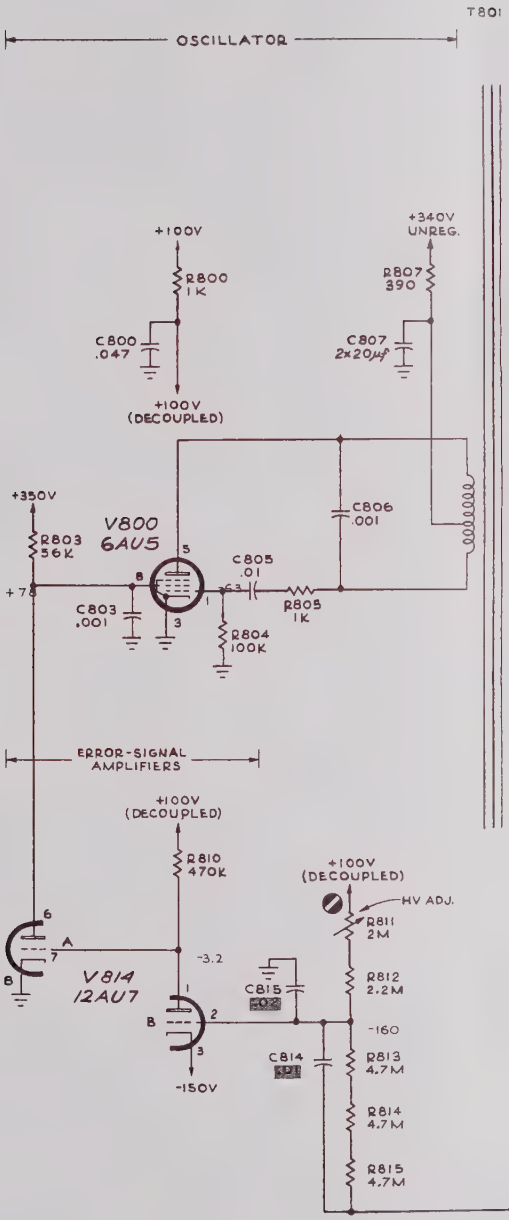
SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED WITH RED TINT BLOCKS

AA₂

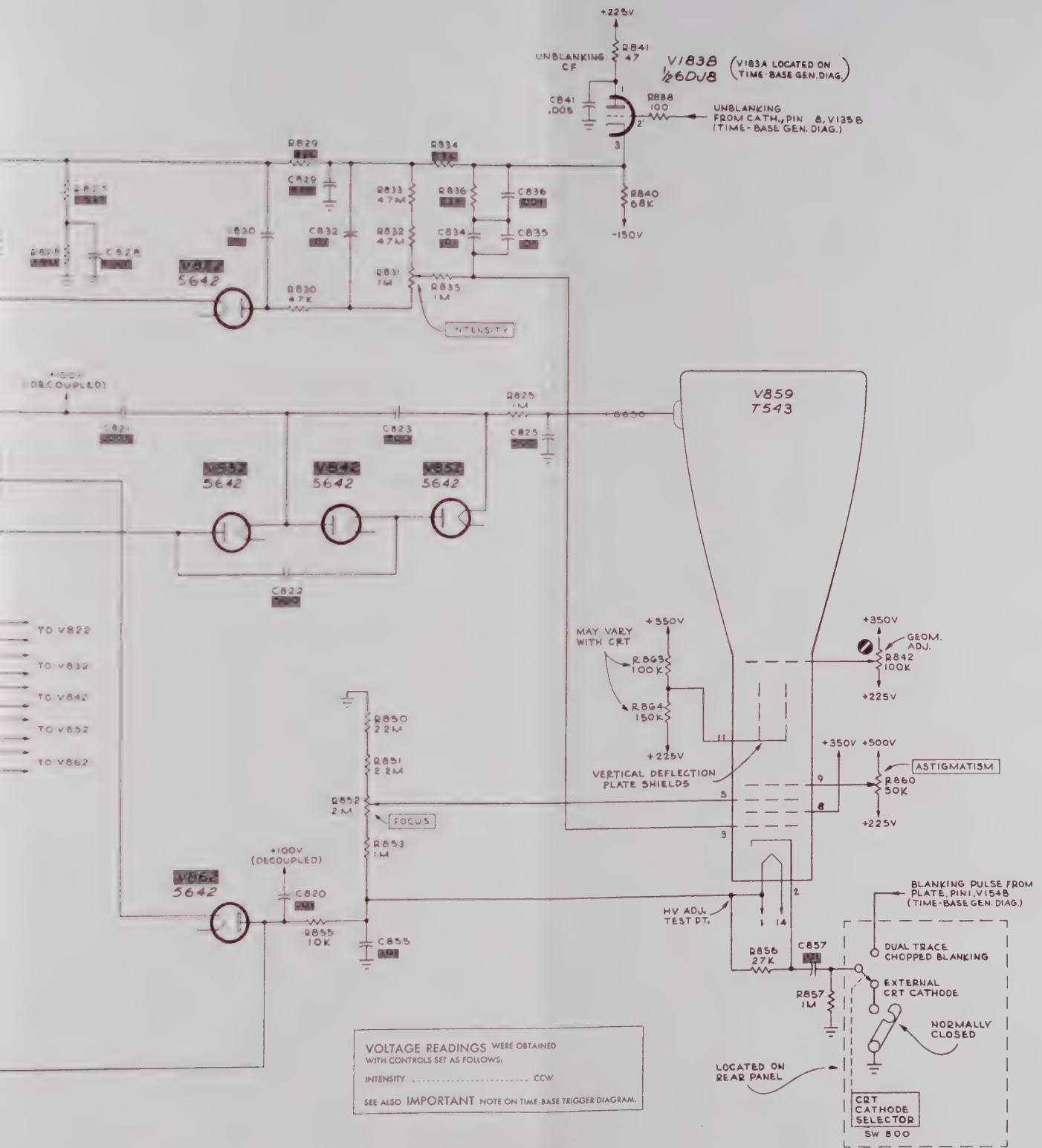
MRH
10-1-62

CALIBRATOR
S/N 101-3000

CIRCUIT NUMBERS 670 THRU 699



TYPE 543/543A OSCILLOSCOPE



VOLTAGE READINGS WERE OBTAINED WITH CONTROLS SET AS FOLLOWS:

INTENSITY ..... CCW

SEE ALSO IMPORTANT NOTE ON TIME-BASE TRIGGER DIAGRAM.

SEE PARTS LIST FOR EARLIER VALUES AND S/N CHANGES OF PARTS MARKED WITH RED TINT BLOCKS

JN
10-8-62

CRT CIRCUIT

CIRCUIT NUMBERS 800 THRU 865

AB3

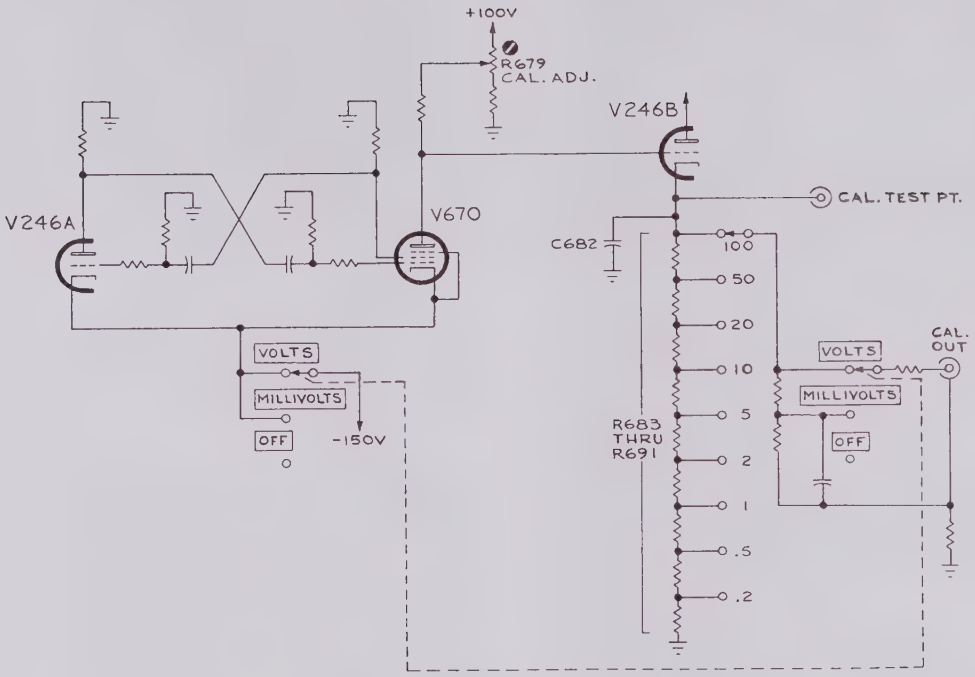


Fig. 4-11. Simplified Type 543 Calibrator.

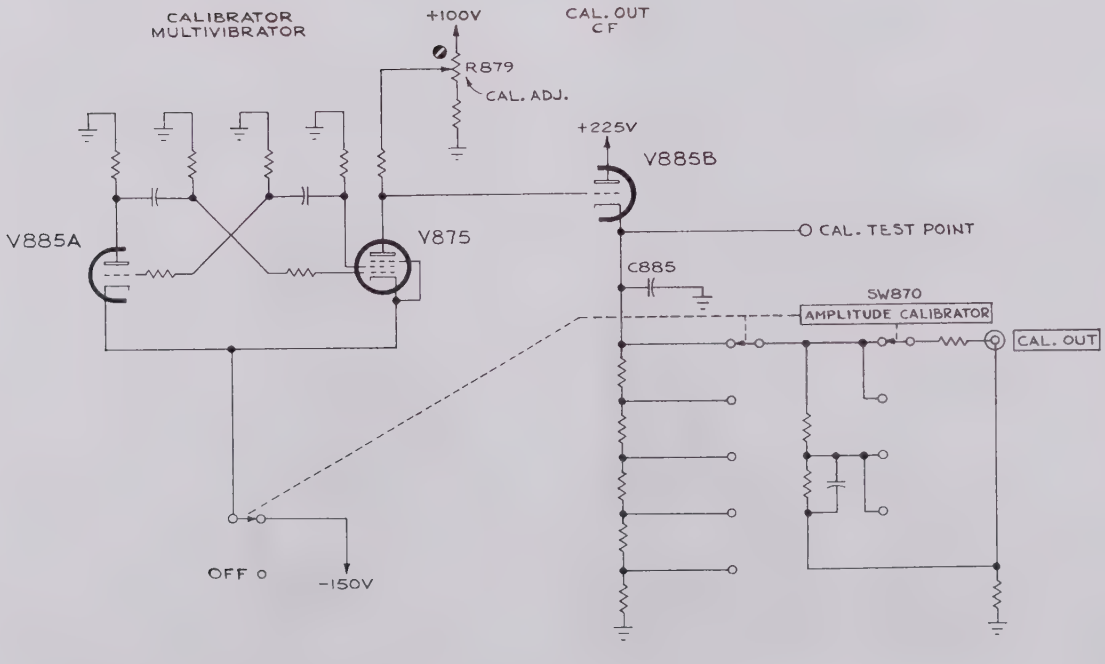


Fig. 4-12. Simplified Type 543A Calibrator.

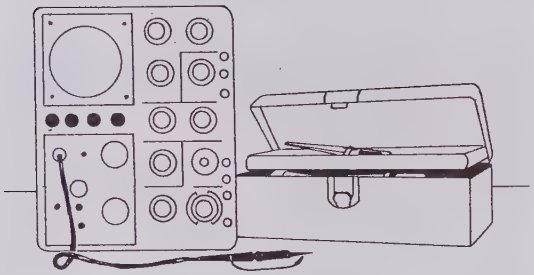
Cathode follower V246A has a precision, tapped divider for its cathode resistor. When the Cal. Adj. control is properly adjusted, the cathode of V246A is at +100 volts when V670A is cut off. By means of the tapped divider R683 through R691 and a second 1000 to 1 divider R694-R695, output voltages from .2 millivolts to 100 volts, in steps, are available. C682, connected between the cathode of V246A and ground, corrects the output waveform for a slight overshoot.

Type 543A

The Type 543A Calibrator is a square-wave generator producing an output at approximately 1 kc which is available at the front panel CAL. OUT connector. It consists of V875 and V885A comprising a multivibrator, connected so as to switch the cathode follower V885B between two operating states, cutoff and conduction.

During the negative portion of the multivibrator waveform the grid of V885B is driven well below cutoff and its cathode rests at ground potential. During the positive portion of the waveform V875 is cut off and its plate rests slightly below +100 volts. The voltage at the grid of V885B when this tube is cut off, is determined by the setting of the Cal. Adj. control R879, part of the divider connected between +100 volts and ground.

Cathode-follower V885B has a precision, tapped divider for its cathode resistor. When the CAL. ADJ. control is properly adjusted, the cathode of V885B is at +100 volts when V875 is cut off. By means of the tapped divider R885 through R893 and a second 1000 to 1 divider R896-R897, output voltages from .2 millivolts to 100 volts in steps are available. C885, connected between the cathode of V885B and ground, corrects the output waveforms for a slight overshoot.



SECTION 5

MAINTENANCE

PREVENTIVE MAINTENANCE

Air Filter

Care must be taken to assure free ventilation of the Type 543/543A inasmuch as some of the components are operated at dissipation levels such that excessive interior temperatures will result without adequate air circulation. To assure free passage of air the instrument must be placed so the air intake is not blocked, and the filter must be kept clean. Moreover, the side panels and bottom cover must be in place for proper air circulation; do not remove the covers except during maintenance.

A washable "E-Z KLEEN" filter is used at the air intake port of the instrument. Under normal operating conditions the filter should be inspected, and cleaned if necessary, every three to four months. More frequent inspection is required when the operating conditions are more severe.

The following cleaning instructions are issued by the filter manufacturer:

(1) If grease or dirt load is light, remove filter from installation and rap gently on hard surface to remove loose dirt. Flush remaining dirt or grease out of filter with a stream of hot water or steam; flush from clean side.

(2) If load is too heavy for treatment described in (1), prepare mild soap or detergent solution in pan or sink deep enough to cover filter when laid flat. Agitate filter up and down in solution until grease or dirt is loosened and floated off.

(3) Rinse filter and let dry.

(4) Dip or spray filter with fresh Filter Coat or Handi-Coater. These products are available from the local representative of the Research Products Corporation, and from most air-conditioner suppliers.

Fan Motor

The fan motor bearings should be lubricated every three or four months with a few drops of light machine oil (see Fig. 5-1). Failure to lubricate the bearings periodically will cause the fan to slow down or stop, thereby causing the instrument to overheat. If your oscilloscope is equipped with a dc fan motor — modification number 101 — and if it operates throughout the working day, we suggest that you oil the bearings lighty once a month.

You should check the condition of the brushes of dc fans every other month since their life expectancy is approximately 6 months under conditions of daily use.

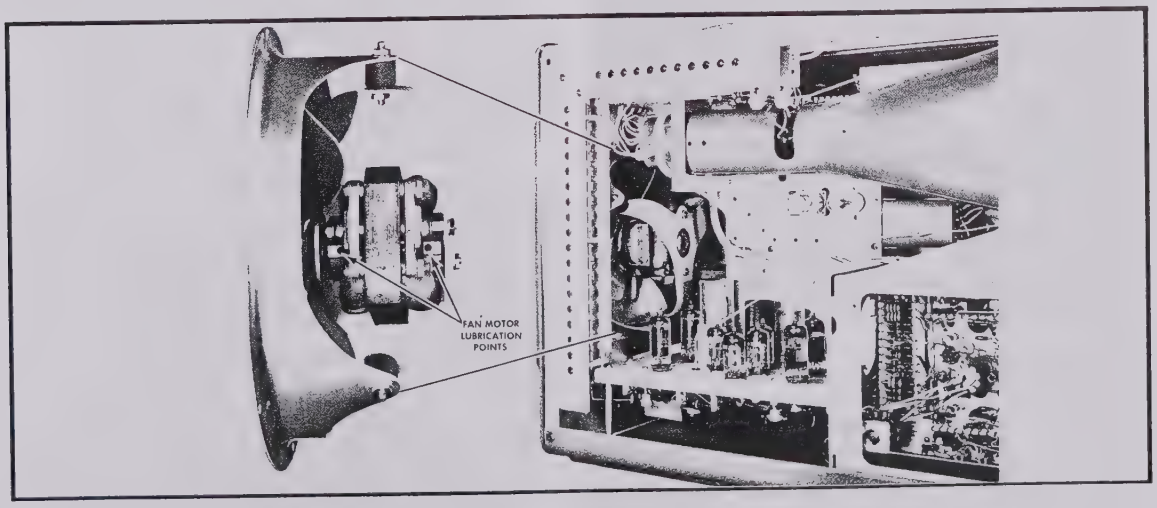


Fig. 5-1. Location of the fan motor lubrication points.

ⒶⒶⓘ

Recalibration

The Type 543/543A is a stable instrument and will provide many hours of trouble-free operation. To insure the reliability of measurements obtained on the Type 543/543A, we suggest that its calibration be checked after each 500 hours of operation, or at least every six months if used intermittently. A check of the calibration also provides a means for checking the operation of each circuit. Minor operational deficiencies that are not apparent in normal use are often detected during a calibration check.

Visual Inspection

You should visually inspect the entire oscilloscope every few months for possible circuit defects. These defects may include such things as loose or broken connections, damaged binding posts, improperly seated tubes, scorched wires or resistors, missing tube shields, or broken terminal strips. For most visual troubles the remedy is apparent; however particular care must be taken when heat-damaged components are detected. Overheating of parts is often the result of other, less apparent, defects in the circuit. It is essential that you determine the cause of overheating before replacing heat-damaged parts in order to prevent further damage.

Soldering and Ceramic Strips

Many of the components in your Tektronix instruments are mounted on ceramic terminal strips. The notches in these strips are lined with a silver alloy. Repeated use of excessive heat, or use of ordinary tin-lead solder will break down the silver-to-ceramic bond. Occasional use of tin-lead solder will not break the bond if excessive heat is not applied.

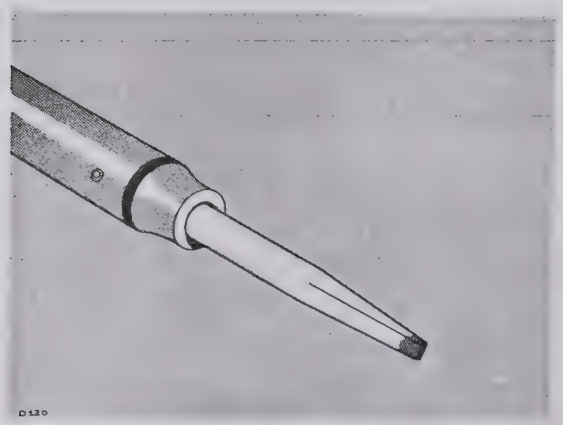


Fig. 5-2. Soldering iron tip properly shaped and tinned.

If you are responsible for the maintenance of a large number of Tektronix instruments, or if you contemplate frequent parts changes, we recommend that you keep on hand a stock of solder containing about 3% silver. This type of solder is used frequently in printed circuitry and should be readily available from radio-supply houses. If you prefer, you can order the solder directly from Tektronix in one pound rolls. Order by Tektronix part number 251-514.

Because of the shape of the terminals on the ceramic strips it is advisable to use a wedge-shaped tip on your soldering iron when you are installing or removing parts from the strips. Fig. 5-2 will show you the correct shape for the tip of the soldering iron. Be sure to file smooth all surfaces of the iron which will be tinned. This prevents solder from building up on rough spots where it will quickly oxidize.

When removing or replacing components mounted on the ceramic strips you will find that satisfactory results are obtained if you proceed in the manner outlined below.

1. Use a soldering iron of about 75-watt rating.

2. Prepare the tip of the iron as shown in Fig. 5-2.

3. Tin only the first 1/16 to 1/8 inch of the tip. For soldering to ceramic terminal strips tin the iron with solder containing about 3% silver.

4. Apply one corner of the tip to the notch where you wish to solder (see Fig. 5-3).

5. Apply only enough heat to make the solder flow freely.

6. Do not attempt to fill the notch on the strip with solder; instead, apply only enough solder to cover the wires adequately, and to form a slight fillet on the wire as shown in Fig. 5-4.

In soldering to metal terminals (for example, pins on a tube socket) a slightly different technique should be employed. Prepare the iron as outlined above, but tin with ordinary tin-lead solder. Apply the iron to the part to be

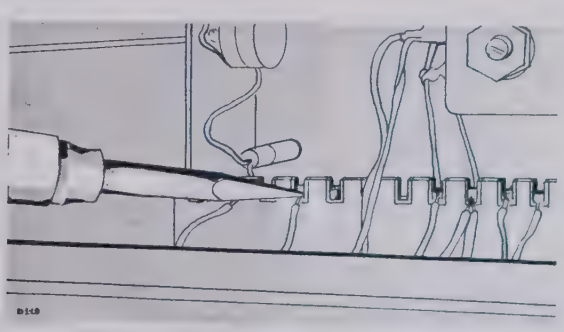


Fig. 5-3. Correct method of applying heat in soldering to a ceramic strip.

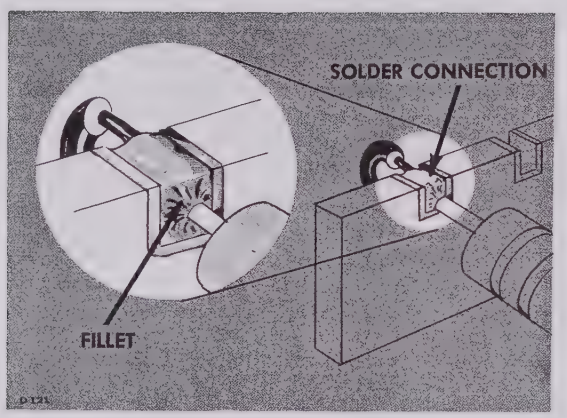


Fig. 5-4. A slight fillet of solder is formed around the wire when heat is applied correctly.

soldered as shown in Fig. 5-5. Use only enough heat to allow the solder to flow freely along the wire so that a slight fillet will be formed as shown in Fig. 5-4.

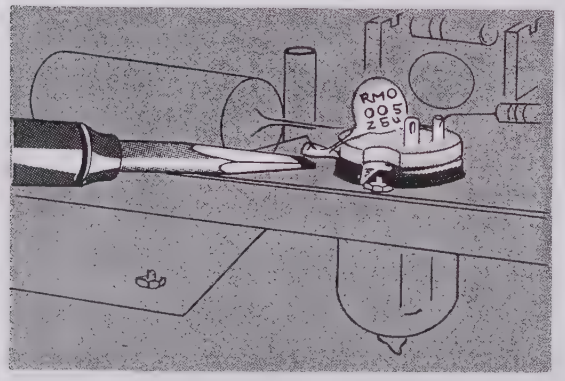


Fig. 5-5. Soldering to a terminal. Note the slight fillet of solder—exaggerated for clarity—formed around the wire.

General Soldering Considerations

When replacing wires in terminal slots clip the ends neatly as close to the solder joint as possible. In clipping the ends of wires take care the end removed does not fly across the room as it is clipped.

Occasionally you will wish to hold a bare wire in place as it is being soldered. A handy device for this purpose is a short length of wooden dowel, with one end shaped as shown in Fig. 5-6. In soldering to terminal pins mounted in plastic rods it is necessary to use some form of "heat sink" to avoid melting the plastic. A pair of long-nosed pliers (see Fig. 5-8) makes a convenient tool for this purpose.

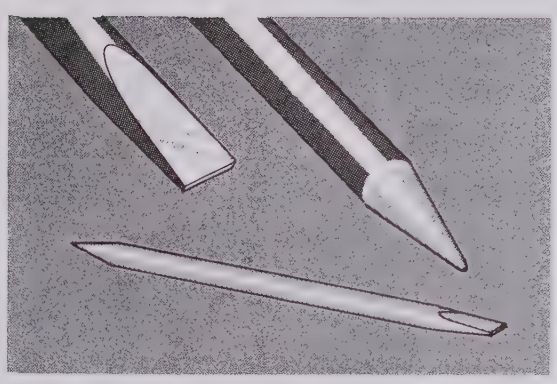


Fig. 5-6. A soldering aid constructed from a ¼ inch wooden dowel.

Ceramic Strips

Two distinct types of ceramic strips have been used in Tektronix instruments. The earlier type mounted on the chassis by means of #2-56 bolts and nuts. The later type is mounted with snap-in, plastic fittings. Both styles are shown in Fig. 5-8.

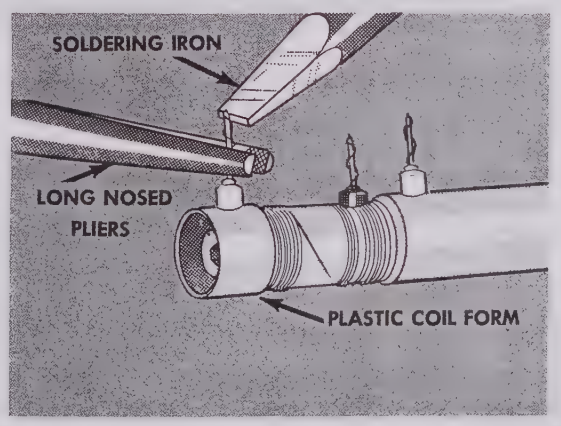


Fig. 5-7. Soldering to a terminal mounting in plastic. Note the use of the long-nosed pliers between the iron and the coil form to absorb the heat.

To replace ceramic strips which bolt to the chassis, screw a #2-56 nut onto each mounting bolt, positioning the bolt so that the distance between the bottom of the bolt and the bottom of the ceramic strip equals the height at which you wish to mount the strip above the chassis. Secure the nuts to the bolts with a drop of red glyptal. Insert the bolts through the holds in the chassis where the original strip was mounted, placing a #2 star washer between each nut and the chassis. Place a second set of #2 flat washers on the protruding ends of the bolts,

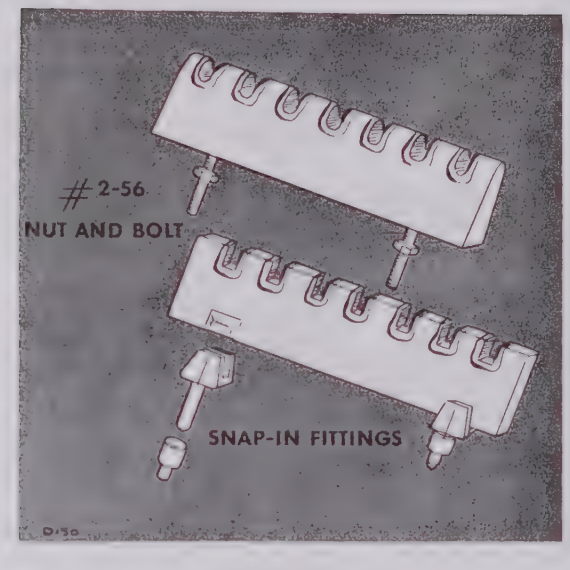


Fig. 5-8. Two types of ceramic strip mountings.

and fasten them firmly with another set of #2-56 nuts. Place a drop of red glyptal over each of the second set of nuts after fastening.

Mounting Later Ceramic Strips

To replace strips which mount with snap-in plastic fittings, first remove the original fittings from the chassis. Assemble the mounting post on the ceramic strip. Insert the nylon collar into the mounting holds in the chassis. Carefully force the mounting post into the nylon collars. Snip off the portion of the mounting post which protrudes below the nylon collar on the reverse side of the chassis.

NOTE

Considerable force may be necessary to push the mounting rods into the nylon collars. Be sure that you apply this force to that area of the ceramic strip above the mounting rods.

TROUBLESHOOTING PROCEDURE

This section of the manual contains information for troubleshooting the Type 543/543A oscilloscope. Before attempting to troubleshoot the instrument, however, make sure that any apparent trouble is actually due to a malfunction within the instrument and not to improper control settings or to a faulty plug-in unit. Instructions for the operation of the Type 543/543A and general information concerning plug-in operation, are contained in the Operating Instructions section of this manual. Operating instructions for a specific plug-in unit will be found in the manual for that unit.

To determine that the oscilloscope is at fault, the plug-in unit may be replaced with another known to be in good operating condition. If the trouble is still apparent, it is almost a certainty that the oscilloscope is at fault. However, should the trouble appear to have been corrected by replacing the plug-in unit, the trouble most likely lies within the original plug-in unit and not with the oscilloscope.

Tube failure is the most prevalent cause of circuit failure. For this reason, the first step in troubleshooting any circuit in the instrument is to check for defective tubes, preferably by direct substitution. Do not depend on tube testers to adequately indicate the suitability of a tube for certain positions within the instrument. The criterion for usability of a tube is whether or not it works satisfactorily in the instrument. Be sure to return all good tubes to their original socket; if this procedure is followed less recalibration of the instrument will be required upon completion of the servicing.

When replacing any tube in the instrument, check first to see that components through which the tube draws current have not been damaged. Shorted tubes will sometimes overload and damaged components can generally be located by a visual inspection of the wiring. If no damaged components are apparent, and if tube replacement does not restore operation, it will be necessary to make measurements or other checks within the circuit to locate the trouble.

The component number of each resistor, inductor, capacitor, vacuum tube, control and switch is shown on the circuit diagrams. The following chart lists the component numbers associated with each circuit.

All numbers less than 100	Time-Base Trigger
All 100 numbers	Time-Base Generator
All 300 numbers	Horizontal Amplifier
All 600 numbers*	Type 543 Square-Wave Calibrator Type 543A Low-Voltage Power Supply
All 700 numbers	Type 543 Low-Voltage Power Supply
All 800 numbers	CRT Circuit and High-Voltage Type 543A Square-Wave Calibrator
All 1000, 1100 and 1200 numbers	Vertical Amplifier
All 1300 numbers	Delay Line

*The Type 543 Calibrator circuit has one tube with V246 number.

Switch wafers shown on the schematic diagrams are coded to indicate the position of the wafer on the actual switches. The number portion of the code refers to the wafer number on the switch assembly. Wafers are numbered from the front of the switch to the rear. The letters F and R indicate whether the front or the rear of the wafer is used to perform the particular switching function.

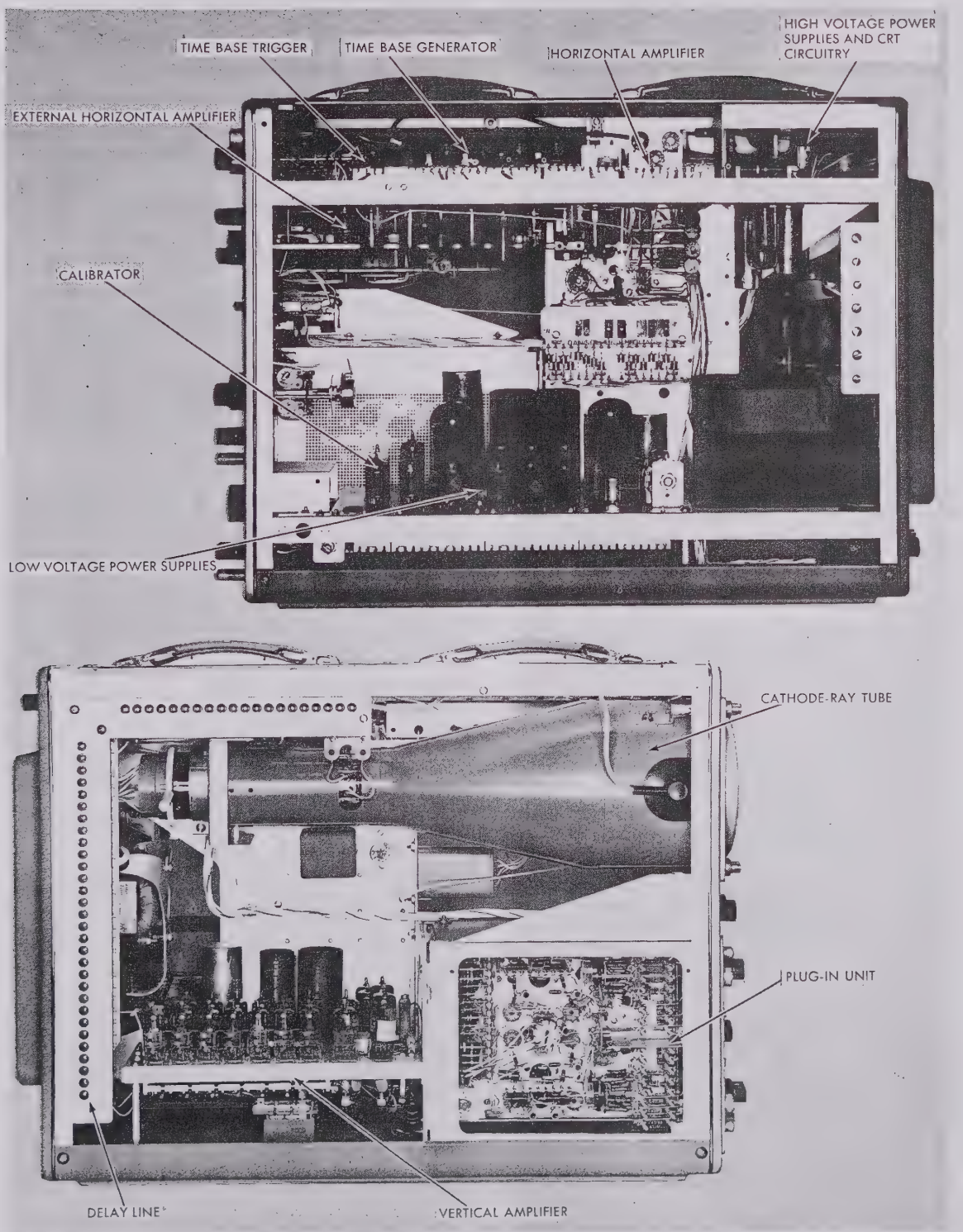


Fig. 5-9. Physical location of the circuits which compose the Type 543/543A Oscilloscope.

Photographic details of these switches are shown on the same fold-out page as the corresponding schematic diagram. These photographs are provided as parts location guides.

CIRCUIT TROUBLESHOOTING

Although the Type 543/543A is a complex instrument, it can be thought of as consisting of six main circuits, in addition to the Calibrator circuit. These are the

1. Low-Voltage Power Supply
2. CRT Circuit and High-Voltage Power Supply
3. Vertical Amplifier and Delay Line
4. Time-Base Trigger Circuit
5. Time-Base Generator
6. Horizontal Amplifier

The first circuit to check, for practically any type of trouble, is the Low-Voltage Power Supply. Because of the circuit configuration employed in the Type 543/543A, it is possible for an improper power supply voltage to affect one circuit more than the others. For example, if the gain of the Vertical Amplifier should decrease slightly, while the other circuits appear to be functioning normally, this could be due to an improper supply voltage and not to any condition originating in the Vertical Amplifier. In cases of this type, valuable time can be saved by checking the power supply first.

On the other hand, the crt display can often be used to isolate trouble to one particular circuit when trouble exists in that circuit. If there is no vertical deflection, for example, when the intensity and horizontal deflection appear to be normal, it is apparent that an open condition exists in the Vertical Amplifier and this circuit should be investigated first.

The material that follows contains information for troubleshooting each circuit for troubles that may be caused by a defect in the circuit. A method is described, in some instances, for locating the stage in which the trouble may be originating; once the stage at fault is known, the component(s) causing the trouble can be located by voltage and resistance measurements or by substitution. In certain other instances the information is more specific and the trouble can be traced to a particular component.

Front-Panel Checks

The following front-panel checks will help you to isolate the trouble in an instrument to a given circuit. The interrelation between circuits is such that these checks are not always completely accurate in isolating a trouble to a given circuit. If you are unfamiliar with the instrument these front-panel checks may prove helpful in starting to look for the trouble.

Before attempting any of the following front-panel checks make sure that the plug-in installed in the instrument is operating correctly. If the pilot lamp fails to light when the POWER switch is turned to the ON position, and if the fan fails to operate, turn to the section on troubleshooting the Low-Voltage Power Supply. If the pilot light and fan both operate but the Time-Delay Relay fails to operate with an audible "click" after one minute, you should also consult the section on Troubleshooting the Low-Voltage Power Supply.

With an operating plug-in installed, and the pilot light and fan both operating, allow the oscilloscope to run for several minutes.

Set the front-panel controls as follows:

STABILITY	full right (clockwise)
TRIGGERING LEVEL	0
TRIGGERING MODE	AC (AC SLOW)
TRIGGER SLOPE	+INT.
VARIABLE (TIME/CM)	full right
TIME/CM	5 mSEC
HORIZONTAL DISPLAY	NORMAL (X1)
FOCUS	mid-scale
INTENSITY	full left (counterclockwise)
ASTIGMATISM	mid-scale
SCALE ILLUMINATION	mid-scale
HORIZONTAL POSITION	mid-scale
VERNIER	mid-scale

The settings of other controls are not critical at this time.

If you are using a Type TU1 or TU2 Test-Load Plug-In Unit set the toggle switch to the 1:1 position and the CALIBRATOR switch to the .2 VOLTS position. If using another type of plug-in set the VOLTS/CM switch to 1 VOLT and the AMPLITUDE CALIBRATOR switch to 2 VOLTS.

Using a patch cord which introduces no attenuation, connect the CAL. OUT connector to the INPUT connector of the plug-in preamplifier. Advance the INTENSITY control to the mid-scale position.

Now examine the face of the crt. If no display is evident examine the Beam-Position Indicator lamps. If the display is positioned off the screen vertically turn the VERTICAL POSITION control from one extreme position to the other, watching the face of the crt as you do so. If no display appears, and operation of the VERTICAL POSITION control has no effect on the Beam-Position Indicator lamps turn to the section on Troubleshooting the Vertical Amplifier.

If the display which appears consists of a horizontal line, you may check the operation of the calibrator by removing the end of the patch cord which is inserted into the CAL. OUT connector and holding it in your hand. A series of sloping vertical lines appearing on the crt indicate that the Vertical Amplifier is operating and that the Amplitude Calibrator is probably inoperative. See the section on Troubleshooting the Amplitude Calibrator for the remedy.

If the operation of the VERTICAL POSITION control causes the vertical Beam-Position Indicator lamps to indicate the display as centered, rotate the HORIZONTAL POSITION control from one extreme position to the other. If the horizontal Beam-Position Indicator lamps still indicate

the display is off the screen refer to the section on Troubleshooting the Horizontal Amplifier.

If both sets of Beam Position lamps indicate that the display is centered, but no display is observed, CAUTIOUSLY advance the INTENSITY control. Watch for a display to appear on the screen. If no display is seen or if the display is of low intensity but otherwise normal, refer to the section on Troubleshooting the CRT Circuit.

TROUBLESHOOTING THE VERTICAL AMPLIFIER

No Spot or Trace Visible on CRT

If all power supply voltages are normal, and the crt is known to be good, failure to obtain a spot or trace on the screen will be due to improper positioning voltages. This condition is caused by a dc unbalance in either or both of the deflection amplifier circuits.

To determine which circuit is at fault, adjust the Time-Base controls for a free-running sweep at 1 millisec/cm (STABILITY control full right) and set the INTENSITY control to midscale. Using a screwdriver with an insulated handle, short the vertical deflection plates together at the neck pins on the crt. These are the pins marked BLUE (UPPER) and BROWN (LOWER). Be extremely careful not to short either pin to the metal shield around the crt, or to the pin marked ORANGE (GEOM). If the dc unbalance is being produced in the vertical deflection circuit the trace will appear at or near the center of the crt when the vertical deflection plates are shorted together. If the trace does not appear, however, the trouble does not lie in the vertical circuit and the dc balance of horizontal circuit can be checked in a like manner.

If it is determined that the vertical deflection circuit is unbalanced, the next step is to check the Delay Line. For this check, and for others to follow, it is convenient to have a short lead (about 6 to 10 inches) with a rubber-covered alligator clip on each end (see Fig. 5-10). Connect this lead across the input to the Delay Line (at the output from the Distributed Amplifier). If the trace appears on the crt the Delay Line is not at fault. If the trace does not appear, check for an open line. This can be done by turning off the instrument and checking the continuity of both sides of the line with an ohm-meter.

If the Delay Line is not at fault, connect the shorting strap across the input of the Distributed Amplifier [grid (pin 1) of V1054 to the grid (pin 1) of V1064]. If the trace does not appear, when these grids are connected together, the trouble lies in the Distributed Amplifier. Check for an open grid or plate line (L1103, L1104, L1113 or L1114). Check R1206 and R1216 at the grid-line termination, and R1071 and R1073 and the associated circuitry at the plate-line termination.

If the trouble is being caused by tubes, it may help to connect the shorting strap between the grids of V1204 and V1214, then move the strap back stage by stage toward V1054 and V1064 until a point is reached where the trace will no longer appear as the opposite grids are connected together. The trouble will then lie in that part of the circuit between the shorting strap and the Delay Line. It is unlikely that just one tube in the Distributed Amplifier could be responsible for the trouble because the current from each tube is only a small portion of the total current flowing in the plate circuit.

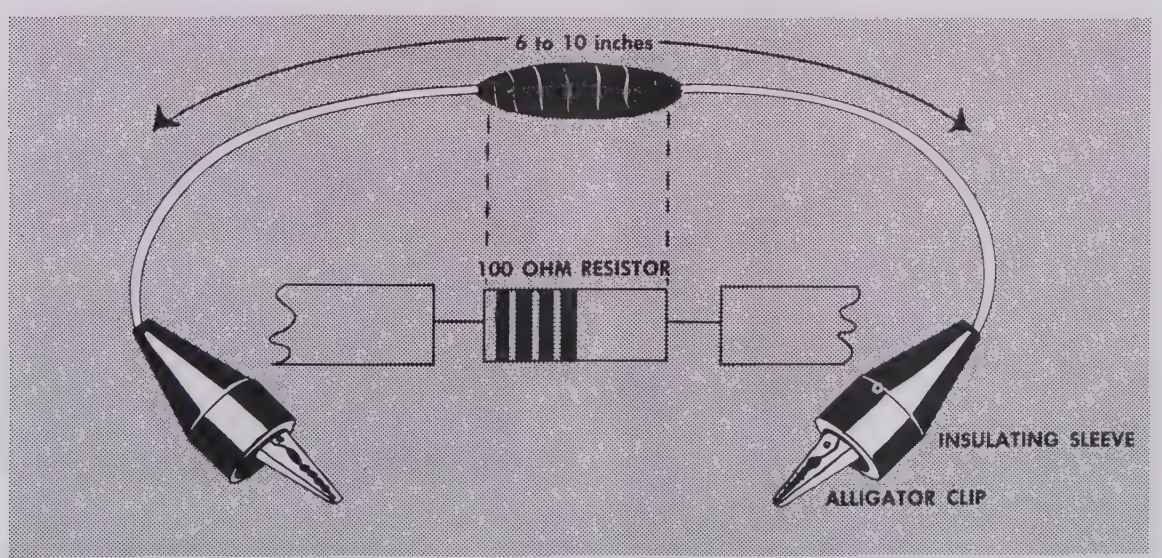


Fig. 5-10. Shorting strap useful in locating an unbalanced stage in a vertical or horizontal amplifier. Insulating tape covers the 100-ohm resistor.

If the trace appears when the input grids to the Distributed Amplifier are connected together, the trouble is occurring ahead of the Distributed Amplifier in one of the input stages. If tube replacement does not correct the trouble, then look for open peaking coils, defective resistors, and shorted or leaky capacitors.

Insufficient or No Vertical Deflection

Insufficient deflection indicates a change in the gain characteristics of the Vertical Amplifier. If only a slight change in deflection is apparent, the circuit can normally be recalibrated for gain. In this event, refer to the Recalibration Procedure section of this manual.

If the change in deflection is more pronounced, or if there is no deflection at all, the tubes should first be checked. Then check for components which can affect the gain of the circuit but not the dc balance. Such components would be the common cathode resistors R1016, R1017, R1055 and R1084, the Gain Adj. control R1027; common screen resistors R1031 and R1218; and common plate-load resistors R1013, R1033 and R1054.

Waveform Distortion

Any waveform distortion that may be produced by the Type 543/543A will generally be of a high-frequency nature. There will be no low-frequency distortion since the deflection circuit is dc-coupled from input to output (unless one or more of the tubes enter into heavy grid current, a condition that will produce other types of distortion as well).

A distortion-free positive step function, having a risetime of 10 millimicroseconds or less, may be used to observe the high-frequency characteristics of the oscilloscope/plug-in combination. This is illustrated in the waveform photographs of Figs. 5-11, 5-12, and 5-13. Fig. 5-11 (a) shows a display of the 3-millimicrosecond risetime square-wave output of the Tektronix Type 107 Square-Wave Generator; this photograph was taken on a standard Type 543 Oscilloscope with a Type K Plug-In Unit. The straight leading edge, square corner and flat top are indicative of the frequency response of a properly adjusted Type 543/K-Unit combination. Fig. 5-11 (b) shows the same waveform except for a small aberration in the top about 2 centimeters to the right of the leading corner. This aberration is known as the termination "bump", and was obtained by detuning the Delay Line termination network slightly. The oscilloscope was adjusted for a sweep rate of .2 μsec/cm for these photographs; the termination bump therefore occurs .4 microsecond after the leading corner. Since the Delay Line is reversed terminated, this corresponds to twice the .2-microsecond delay time of the circuit.

Any waveform distortion that may be produced by the vertical deflection circuit will occur between the leading corner and the termination bump. The vertical deflection circuit in the Type 543/543A may be divided into three parts, and each part will affect the waveform in a different manner. An analysis of the distortion is therefore helpful in determining which part of the circuit is at fault. The three parts are:

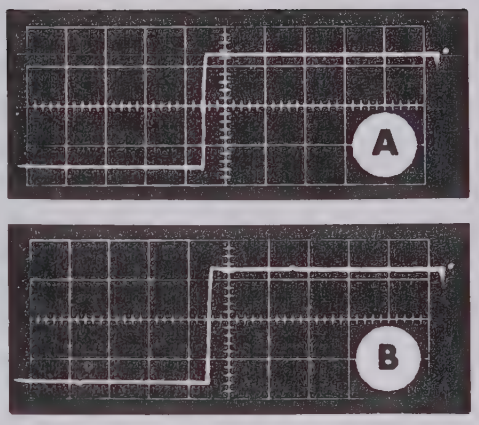


Fig. 5-11. (a) A 450-kc, 3 nanosecond risetime square wave display on properly adjusted Type 543/K-unit combination. (b) The small aberration in the top of the waveform is a termination bump produced by an improperly terminated Delay Line.

(1) The plug-in unit and input stage of the main Vertical Amplifier.

(2) The Distributed Amplifier.

(3) The Delay Line.

The plug-in unit and the input stage of the main Vertical Amplifier will affect only the leading corner of the step function. Assuming the trouble is not being caused by the plug-in unit, the Input Amplifier stage V1014 and V1024, and the cathode follower circuit V1033 and V1043 can be investigated for the type of distortion shown in Fig. 5-12. Fig. 5-12 (a) shows rolloff, or undershoot, at the leading corner of the step function. Rolloff is the result of insufficient high-frequency compensation. A small amount of rolloff is normally due to a change, with age, in the characteristics of the circuit components, and can usually be compensated by adjusting the variable peaking coils. If the rolloff is more pronounced the tubes should be checked. If a tube cannot deliver current, instantaneously on demand, the transients in the signal will not be produced.

Shorted or partially shorted peaking coils will result in a rolloff. Be especially careful when soldering around the peaking circuits as hot solder dropping on a coil may burn through the insulation and short the turns.

Ringing at the leading corner, shown in Fig. 5-12 (b), is produced by an overcompensated amplifier. This is generally caused by misadjusting the peaking coils. An overshoot at the leading edge, without ringing, can also be produced by an over-compensated amplifier; in this case the degree of compensation is not sufficient to produce ringing. In both of these cases the distortion can generally be eliminated by readjusting the variable peaking coils.

An overshoot at the leading edge of a fast-rise pulse may also be the result of cathode interface in one of the

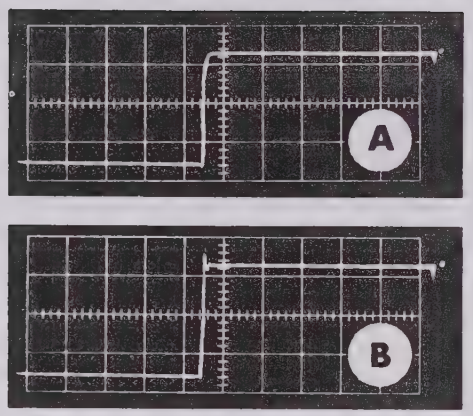


Fig. 5-12. (a) Rolloff at leading corner caused by an under compensated Input Amplifier stage.

(b) Ringing produced by an overcompensated Input Amplifier stage.

amplifier tubes. Since the time constant of the interface layer is normally in the range from .1 to 3 μsec, this effect is most noticeable on waveforms whose period is long compared to the interface time constant. This condition is produced by the tubes themselves, so it is important to first check the tubes when such distortion is evident.

The Distributed Amplifier will affect the step function both at the leading corner and in the vicinity of the termination bump. A typical example is that shown in Fig. 5-13 (a). The rounded corner, and the aberrations about .4-μsec following the corner were produced by replacing V1204 with a tube whose Gm was quite low. This points up the importance of the tubes in maintaining the proper frequency response in pulse amplifiers. Other factors causing similar effects would be shorted coils in the plate and grid lines, off-value resistors, leaky or open capacitors, or improper adjustment of the capacitors across the plate lines.

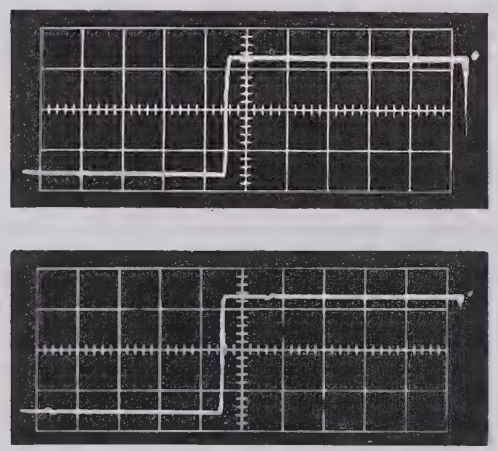


Fig. 5-13. (a) Rolloff and aberrations in top of pulse are due to a low-Gm tube in the Distributed Amplifier.

(b) Small aberrations in the top of pulse are caused by a slightly misadjusted portion of the Delay Line.

The Delay Line will affect the pulse from the corner to the termination bump. If the line is badly detuned the top of the pulse will be uneven, instead of smooth and flat as shown in Fig. 5-11 (a), and the leading corner may either overshoot or rolloff. If just one or two sections of the line are detuned, either due to a shorted coil or a defective capacitor, an aberration will appear in the waveform in the region affected by the defective component.

Since the Delay Line is reverse terminated, the end of the line nearest the cathode ray tube will affect the start of the pulse, and the beginning of the line (at the output of the Distributed Amplifier) will affect the waveform in the region of the termination bump. Sections of the line between the two ends will affect the waveform in the region between the corner and the termination bump. The location of an aberration in the top of the pulse, with respect to the leading corner and the termination bump, will indicate the relative section of the line in which the trouble is occurring. For example, the small aberrations shown in Fig. 5-13 (b) were produced by slightly detuning two sections of the line about midway between the Distributed Amplifier and the cathode ray tube.

TROUBLESHOOTING THE TIME-BASE TRIGGER CIRCUIT

Unstable Triggering

If the sweep generator is not being properly triggered a stable display of a waveform will not be possible. If the sweep can be turned off and on with the STABILITY control (for the setting of the TRIGGERING MODE switch except AUTOMATIC) the sweep generator is capable of being triggered; this indicates the trigger circuitry is not functioning properly. The first step is to replace the Trigger Pickoff tube V1223 in the Vertical Amplifier. The operation of this stage can also be checked by observing the signal available at the VERT. SIG. OUT binding post with another oscilloscope. If no signal is available at this connector the Trigger Pickoff stage is defective; a proper signal at this connector indicates the stage is functioning correctly.

If the Trigger Pickoff stage is operating correctly, trouble exists in the Time-Base Trigger circuit. To check the quiescent stage of this circuit, set the TRIGGERING MODE switch to AC SLOW (AC), the TRIGGER SLOPE switch to —INT., and the TRIGGERING LEVEL control to 0. Next, connect a jumper wire from the function of R19, R20 and C20 (on the Trigger Switch; see Fig. 6-2) to ground. This fixes the voltage at the grid of V24B at ground potential. Then measure the voltage at the plate of V24B; this should be about +85 volts. If this voltage does not measure very close to +85 volts, replace the Trigger Input tube V24. If necessary, check for off-value resistors, broken leads and poor switch contacts.

The next step is to connect the voltmeter between the plate of V24B and the grid of V45B (the junction of R40, R42, C42 and R47 is more convenient than the grid of V45B). The voltage between the plate of V24B and the grid of V45B (or the divider side of R47) should not exceed about 2.75 volts. It is the function of the Triggering Level Centering control R39 to set the voltage at the grid of V45B approximately equal to the voltage at the grid of V45A. With the grids of the V45 at about the same voltage the center of the hysteresis of the Schmitt Trigger circuit will be at the proper level. It is difficult to measure the voltage directly between the two grids of V45 due to the loading of the voltmeter; for this reason we suggest the voltage be measured between the plate of V24B and the grid circuit of V45B. A voltage of 2.5 to 2.75 volts between these points will indicate proper quiescent operation.

If the voltage at the grid of V45B cannot be adjusted to within 2.5 to 2.75 volts of the voltage at the plate of V24B, trouble in the Schmitt multivibrator is indicated. Replace the tube; then, if necessary, check for off-value resistors, broken leads and poor switch connections.

Conversely, if the voltages are found to be correct, the adjustment of the Trigger Sensitivity control R37 can be checked. Refer to Step 7 in the Recalibration Procedure for the proper method of checking the adjustment of this control.

When triggering in the DC mode from the signal being observed (TRIGGER SLOPE at + or —INT.), the Int. Trig. DC Level Adj. R3 and its associated components are connected to the input grid of V24. This control is adjusted so that the input grid (pin 7 at —INT; pin 2 at +INT.) is at ground potential when the trace is centered vertically on the crt. If the voltage at the input grid cannot be adjusted to zero, when the triggering-switch controls are in the indicated positions, this control and its associated components should be checked.

TROUBLESHOOTING THE TIME-BASE GENERATOR

No Horizontal Sweep

If the Time-Base Generator is not producing a sawtooth sweep voltage, when the STABILITY control is adjusted for a free-running sweep, some defect in the generator is hanging up the Miller circuit. Depending on the on-off characteristics of the diodes V152, the Miller circuit may be hung up at either the high end or the low end of the sawtooth. The manner in which it is hung up may be determined by measuring the voltage at the SAWTOOTH OUT binding post. If the Miller circuit is hung up at the high end of the sawtooth the voltage at the front-panel binding post will measure about +200 volts; if hung up at the low end, the voltage at this point will measure anywhere between ground and —20 to —30 volts, depending on the cause.

If the Miller circuit is hung up at the high end of the sawtooth, a check of the voltage at the grid of the Miller tube will offer a clue to the cause of the trouble. The static voltage at the Miller grid is determined by conduction through the Timing Resistor R160 (from —150-volt bus), the lower diode V152A, and the divider R147-R148. It will be impossible to measure the exact voltage at the Miller grid because of the loading of the meter. However, if a 20,000-Ω/v meter, or a vacuum-tube voltmeter is used, the voltage reading obtained will be sufficient to indicate the source of the trouble. For example, if a voltage reading more negative than about —15 volts is obtained, there is probably no conduction through the Timing Resistor. This would indicate an open divider R147-R148, assuming the diode V152 to be good.

If the Miller circuit is hung up at the low end of the sawtooth, as indicated by a voltage reading of zero or a few volts negative, a check of the voltage at the plate of the Miller tube will offer a clue to the cause. If this voltage is quite high (about + 350 volts), check the neon lamp B167 and the Runup CF tube V173. If the voltage at the plate of the Miller tube is zero or slightly negative, check for an open plate-load resistor R164, R165 or R166.

However, if the voltage at the plate of the Miller tube is near the quiescent level (about + 45 volts) the trouble will generally lie ahead of the Miller tube. The result of the trouble is that the On-Off Diodes V152 cannot be gated off; they are conducting heavily and clamping the grid of the Miller tube near ground. If all of the tubes have been checked, then check for open plate and cathode resistors in the Sweep-Gating Multivibrator circuit, the Hold-Off circuit and the Runup CF circuit. Also check that the STABILITY control can vary the voltage at the grid of V135A.

Improper Triggering

If the sweep cannot be triggered properly, the gating pulse from the Multivibrator is not turning the diodes V152 off and on properly. The start of the gating pulse, which turns the diodes off and starts the sweep, is initiated by the triggering pulse at the grid of V135A. The end of the gating pulse, which turns the diodes on and initiates the retrace, is controlled by the hold-off waveform at the grid of V135A. The Sweep-Gating Multivibrator can be eliminated as the cause of the trouble if the sweep can be turned off and on with the STABILITY control. The main component to check, in addition to the tubes, is the differentiating capacitor C131.

Nonlinear Sweep

A nonlinear sweep voltage will be generated if the current charging the Timing Capacitor C160 does not remain constant. If the nonlinearity occurs at all sweep rates a defective Miller tube will be the probable cause. If the nonlinearity occurs only at certain sweep rates a leaky Timing Capacitor will be the probable cause but the Miller tube should not be overlooked. A defective bootstrap capacitor C165 can cause the sweep to be nonlinear at the faster sweep rates.

Insufficient Horizontal Deflection

If the horizontal trace starts at the left side of the graticule, but does not extend to the right side, the Hold-Off circuit is causing V135A to conduct too soon after the triggering pulse had forced it into cutoff. If the trace cannot be expanded the full length of the graticule with the SWP. LENGTH control R176, check the resistance values in the cathode circuit of V173.

TROUBLESHOOTING THE HORIZONTAL AMPLIFIER

No Spot or Trace Visible on CRT

To determine that the Horizontal Amplifier is in a state of dc unbalance, short the horizontal deflection plates together at the neck pins of the crt in the manner explained for the troubleshooting the Vertical Amplifier. The horizontal deflection plates are marked RED (LEFT) and GREEN (RIGHT). The INTENSITY control should be set to mid-scale. If a spot appears when the horizontal deflection plates are shorted together (it may be necessary to adjust the VERTICAL POSITIONing control), the trouble lies in the Horizontal Amplifier.

CAUTION: Do not permit the spot to remain on the crt at this setting of the INTENSITY control. Either reduce the intensity until the spot is just visible, or remove the short from the horizontal deflection plates.

The procedure for troubleshooting the Horizontal Amplifier, to locate the defective stage, is similar to that explained for troubleshooting the Vertical Amplifier for unbalance. The shorting strap can be moved from the deflection plates back toward the Input Amplifier stage, until a point is reached where the trace does not appear. When the stage at fault is determined, check for defective tubes and components associated with that stage.

Insufficient or No Horizontal Deflection

If the gain of the Horizontal Amplifier decreases, the trace will not extend from the left to the right side of the graticule. In addition, the timing will no longer correspond to the calibrated value indicated by the TIME/CM switch. (This is to distinguish the condition of insufficient sweep produced by a malfunction in the Horizontal Amplifier from that produced by a malfunction in the Hold-Off circuit in the Time-Base Generator, e.g., an improper adjustment of the SWP. LENGTH control. In the latter case the trace will start at the left side of the graticule, for the normal setting of the HORIZONTAL POSITION control, and the timing will not be affected.)

If the change in gain is slight, as indicated by improper timing and a slightly decreased sweep, the amplifier can usually be recalibrated. Since the gain of the Horizontal Amplifier regulates the timing of the sweep, care must be taken to insure that the gain adjustments are accurately made. Be sure to refer to the Recalibration Procedure if it is necessary to adjust the gain of the Horizontal Amplifier.

If the decrease in gain of the Horizontal Amplifier is more pronounced, or if there is no sweep at all (in which case only a spot will be visible on the horizontal axis), check for defective components which can affect the gain but not the dc balance. In addition to the tubes, such components would be the common cathode resistors and controls.

TROUBLESHOOTING THE LOW-VOLTAGE POWER SUPPLY

Proper operation of every circuit in the Type 543/543A including the plug-in unit, depends on proper operation of the Low-Voltage Power Supply. The regulated dc voltages must remain within their specified tolerances for the instrument and plug-in unit to retain their calibration.

CAUTION

Exercise care in checking the power supply. Because of their high current capabilities and low impedance, the Low-Voltage supplies can produce more harmful shocks than the high-voltage supply in the CRT circuit.

Open Power Circuit (Dead Circuit)

If the pilot lamp and the fan do not come on when the power is turned on, check the source of power and the power cord connections. Check the fuse at the rear of the instrument. If the fuse is blown replace it with one of the proper value and turn the instrument on again. If the

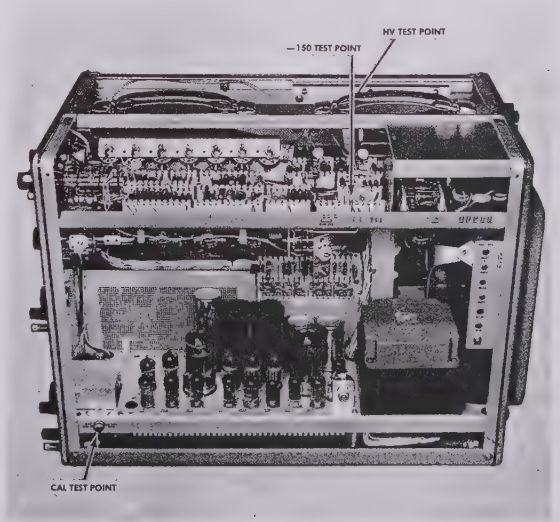


Fig. 5-14. Location of Power Supply and Calibrator test points.

new fuse blows immediately, check the power transformer for shorted primary or secondary windings. Also check for a shorted rectifier stack. If the new fuse does not blow until the time-delay relay has activated (a "click" can be heard), check for a shorted condition in the regulator circuits and the loading on the supply.

If the fuse is good, check for an open primary winding in the power transformer. If your instrument is wired for 234-volt operation, check for an open Thermal Cutout Switch, the resistance of this switch is about .1Ω. (If your instrument is wired for 117-volt operation, the fan will come on even though the Thermal Cutout Switch is located on the vertical chassis toward the right rear of the instrument.)

If both the fan and pilot lamp come on, the primary circuit of the power transformer is operating normally.

Incorrect Output Voltage

Test points for checking the Low-Voltage Power Supply are located on the right side of the instrument, near the top, in front of the shield covering the high-voltage transformer (see Fig. 5-14). The voltage for each test point is silk-screened on the lip of the chassis adjacent to the ceramic strip on which the test points are located. Each regulated bus is identified by a color-coded wire. The —150-volt bus is coded brown, green and brown on a black wire; the +100-volt bus is coded brown, black and brown on a white wire; the +225-volt bus is coded red, red and brown on a white wire; the +350-volt bus is coded orange, green and brown on a white wire; and the +500-volt bus is coded green, black and brown on a white wire.

If any of the supplies fail to regulate the first thing to check is the line voltage. The supplies are designed to regulate between 105 and 125 volts with the design center at 117 volts, or between 210 and 250 volts with the design center at 234 volts, rms, 50-60 cycle single phase ac.

If the line voltage is the correct value, the next step is to remove the plug-in unit and measure the resistance between each regulated bus and ground. The following resistance values are approximate minimum readings; the actual resistance between each bus and ground will generally be higher than the values indicated here.

REGULATED BUS	APPROX. MINIMUM RESIST. TO GROUND
—150 v	3.5 k
+100 v	5 k
+225 v	10 k
+350 v	30 k
+500 v	35 k

If the resistance values between the regulated buses and ground check out, check the tubes (if this has not already been done). Then make sure that the line voltage is set near the design center for your instrument (117 or 234 v) and check the rms voltage across the secondary winding for each supply; the nominal value of each secondary voltage, when the line is set to the design center, is indicated on the circuit diagram. If the secondary voltages are all correct, check the operation of the bridge rectifiers. This can be done by measuring the rectified voltage at the input to each regulator. These values are also indicated on the circuit diagram. Then check for off-value resistors, especially in the dividers, and for open or leaky capacitors.

The material that follows may be used as a quick index for troubleshooting the regulator circuits:

If the output voltage is high with excessive ripple, check:

a. For high line voltage.

b. For open voltage-regulator tube.

c. The amplifier tubes in the regulator circuit.

d. For insufficient loading.

If the output voltage is high with normal ripple, check:

a. For proper resistance values in the dividers refer to the schematic for your instrument to determine the location of the resistors involved. Since these are generally precision resistors (±1% tolerance) the use of a good bridge is recommended in checking the value.

If the output is low with excessive ripple, check:

a. For low line voltage.

b. For shorted voltage-regulator tube.

c. The series tubes in the regulator circuit.

d. For excessive loading.

e. Open or leaky filter capacitors.

f. Defective rectifiers.

If the output is low with normal ripple, check:

a. The resistance values in the dividers.

b. The capacitors across the dividers.

IMPORTANT: If any components in the —150-volt supply are changed, or if the setting of the —150 Adj. control is changed, it will be necessary to recalibrate the instrument.

TROUBLESHOOTING THE CALIBRATOR

If the output square wave is not symmetrical (the positive portion has a duration different from that of the negative portion), the two tubes in the Multivibrator circuit are not being held cutoff for equal periods. This will normally be caused by a defective tube. If tube replacement does not correct the waveform the circuit components must be checked. In Type 543A the pentode in the Multivibrator is held cutoff for an interval determined by the discharge of C871 and the triode is held cutoff for an interval determined by the discharge of C874. A change in the value of either capacitor, or in the value of the resistor through which they discharge, could produce an asymmetrical waveform.

In addition, the time needed for these capacitors to discharge a given amount is affected by the potential toward

which they discharge; this would be the voltage at the plate of the triode in the case of C871, and the voltage at the screen of the pentode in the case of C874. Since these voltages are affected by the value of R870 and R875, these resistors should be checked. The resistors in the plate circuit of the pentode should also be checked, since they will affect the plate-to-screen ratio of the pentode.

In Type 543 Oscilloscopes, the interval of pentode discharge is determined by C673, and that of triode discharge by C672. With reference to potential toward which the capacitors discharge, C673 discharges toward the triode plate, and C672 toward the pentode screen. These voltages are affected by R670 and R675.

Incorrect Output Voltage

The amplitude of the output square wave is determined almost entirely by the resistance values in the divider in the cathode-follower stage. A quick check of the resistance values can be made by turning off the Calibrator and measuring the voltage at the Cal. Test Pt; if this point does not measure exactly +100 volts the output voltages, when the Calibrator is turned on, will not be correct.

The Cal. Adj. control R879 in Type 543A, R679 in Type 543 will vary the voltage at the test point over about a 10-volt range. If this voltage cannot be set to exactly +100 volts, and if the tubes have been replaced, then one or more of the precision resistors in the divider have changed in value.

TROUBLESHOOTING THE CRT CIRCUIT

The intensity, focus, geometry and calibration of the crt display depend on proper operation of the three high-voltage supplies in the CRT Circuit.

No Intensity

If the low-voltage power supply is operating normally, but no spot or trace is visible on the crt, the trouble could be a defective crt, a defect in the crt cathode circuit including the —1350-volt supply, or an unbalanced dc condition in either or both of the deflection amplifiers. In the latter case the dc unbalance is producing improper positioning voltages and the beam is being deflected off the screen.

To determine which circuit is at fault, turn the INTENSITY control full right (cw). If a flare is observed on the crt screen (it may be necessary to darken the room), one of the deflection amplifiers is probably at fault; the procedure for troubleshooting these circuits precedes in this section. If no flare is observed with the INTENSITY control turned full right, the trouble will either be due to a defective crt or to an inoperative cathode supply circuit (V820 rectifier circuit). The cathode supply can be checked by measuring the voltage at the HV Adj. Test Point. This test point is accessible through a hole in the shield at the top left rear of the instrument. The voltage at this point should be —1350 volts, although it will vary with the setting of the HV Adj control R811. If a voltage reading in the vicinity of —1350 volts is obtained, turn the instrument off and remove the shield covering the test point. Then measure the resistance of R856, the 27-k resistor connected to the test point. If this resistor is not open a defective crt is indicated.

If the voltage at the HV Adj. Test Point is zero or abnormally low replace the Oscillator tube V800 and the Error-Signal Amplifier tube V814. If this does not restore operation the Oscillator circuit should be checked.

A quick check on the operating of the Oscillator circuit can be made by observing the heater glow in the 5642 rectifier tubes, located under the shield at the upper right rear of the instrument. These tubes are visible through the opening in the side of the shield. If no heater glow is visible the Oscillator circuit is inoperative. This could be due to an open transformer T800, or to a defective component in the circuit of V800 or V814.

If heater glow is visible in the rectifier tubes, the Oscillator circuit is operating. If the heater glow appears to be dim, however, the output of the Oscillator may be insufficient for proper operation. A more accurate check on the Oscillator may be made by removing the shield covering the high-voltage transformer and measuring the bias at the grid of V800. This can be measured at the junction of the 100-k resistor R804 and the .01-μfd capacitor C805, located on the ceramic terminal strip near the post that supports the front of the shield. The voltage at this point should measure about —65 volts.

CAUTION: Do not let your hand or body touch the chassis when making this check. Secondary reactions to an otherwise harmless shock might result in a painful injury.

If the Oscillator circuit is operating properly, but the voltage of the HV Adj. Test Point does not measure in the vicinity of —1350 volts, the 5642 rectifier tube V820 is most likely defective.

Abnormal Intensity

If a trace is visible on the crt, the relative intensity of the trace may be used to identify trouble in either the negative bias supply or the positive anode supply.

If the trace is excessively brilliant, and if the brilliancy does not change as the INTENSITY control is adjusted, check the negative bias supply including the lead to pin 3 on the crt socket. Check for a defective rectifier tube V824, an open supply winding or filament winding, an open resistor including the INTENSITY control, or a shorted or leaky capacitor. If trouble is not found in any of these components, a defective crt is indicated.

If the intensity of the trace is extremely low, check for an inoperative positive supply. Also check the anode connection to the crt, including R825 and C825.

If the accelerating potentials appear to be too high, as evidenced by decreased deflection sensitivity, check the Error-Signal Amplifier circuit.

If a badly distorted trace or spot is visible on the crt, check the Geom. Adj. control R842 and its connection to

the neck pin on the crt, and the ASTIGMATISM control R860 and its connection to the crt base socket. If the FOCUS control has no effect on the trace, check this control (R852) and its connection to the crt base socket.

IMPORTANT: If any components in the Oscillator, Error-Signal Amplifier or —1350-volt cathode supply circuit are changed, or if the setting of the HV Adj. control is changed, it will be necessary to recalibrate the instrument.

SECTION 5.1

PREVENTIVE MAINTENANCE INSTRUCTIONS

5.1-1. Scope of Maintenance

The maintenance duties assigned to the operator and organizational repairman of the equipment are listed below together with a reference to the paragraphs covering the specific maintenance functions.

a. Daily preventive maintenance checks and services (para 5.1-4).

b. Weekly preventive maintenance checks and services (para 5.1-5).

c. Monthly preventive maintenance checks and services (para 5.1-6).

d. Quarterly preventive maintenance checks and services (para 5.1-7).

e. Cleaning (para 5.1-8).

f. Touchup painting (para 5.1-9).

5.1-2. Preventive Maintenance

Preventive maintenance is the systematic care, servicing, and inspection of equipment to prevent the occurrence of trouble, to reduce downtime, and to assure that the equipment is serviceable.

a. Systematic Care. The procedures given in paragraphs 5.1-8 and 5.1-9 cover routine systematic care and cleaning essential to proper upkeep and operation of the oscilloscope.

b. Preventive Maintenance Checks and Services. The preventive maintenance checks and services charts (para 5.1-4 through 5.1-7) outline functions to be performed at specific intervals. These checks and services are to maintain Army electronic equipment in a combat serviceable condition; that is, in good general (physical) condition and in good operating condition. To assist operators in maintaining combat serviceability, the charts indicate what to check, how to check, and the normal conditions; the References column lists the illustrations, paragraphs, or manuals that contain detailed repair or replacement procedures. If the defect cannot be remedied by performing the corrective action indicated, higher level maintenance or repair is required. Records and reports of these checks and services must be made in accordance with the requirements set forth in TM 38-750.

5.1-3. Preventive Maintenance Checks and Services Periods

Preventive maintenance checks and services of the equipment are required daily, weekly, monthly, and quarterly.

a. Paragraph 5.1-4 specifies the checks and services that must be accomplished daily (or at least once each week if the equipment is maintained in standby condition).

b. Paragraphs 5.1-5, 5.1-6, and 5.1-7 specify additional checks and services that must be performed on a weekly, monthly, and quarterly basis, respectively.

5.1-4. Operator's Daily Preventive Maintenance Checks and Services Chart

Sequence No.	Item to be inspected	Procedure	References
1	Completeness	See that the equipment is complete (appx II).	None.
2	Exterior surfaces	Clean the exterior surfaces, including the panel (para 5.1-8). Check the graticule lens for scratches.	None.
3	Connectors	Check the tightness of all connectors	None.
4	Controls and indicators	While making the operating checks (item 5), observe that the mechanical action of each switch and control is smooth and free of external or internal binding, and that there is no excessive looseness.	None.
5	Operation	During operation, be alert for any unusual performance or condition.	None.

5.1-5. Organizational Weekly Preventive Maintenance Checks and Services Chart

Sequence No.	Item to be inspected	Procedure	References
1	Cables	Inspect cords, cables, and wires for chafed, cracked, or frayed insulation. Replace connectors that are broken, arced, stripped, or worn excessively.	None.
2	Handles	Inspect handles for looseness. Replace or tighten as necessary.	None.
3	Metal surfaces	Inspect exposed metal surfaces for rust and corrosion. Touchup paint as required (para 5.1-9).	None.

5.1-6. Organizational Monthly Preventive Maintenance Checks and Services Chart

Sequence No.	Item to be inspected	Procedure	References
1	Pluckout items	Inspect seating of pluckout items. Make certain that the tube clamps grip the tube bases tightly.	None.
2	Jacks and plugs	Inspect jacks and plugs for snug fit and good contact.	None.
3	Transformer terminals	Inspect the terminals on the power transformer. All nuts must be tight. There should be no evidence of dirt or corrosion.	None.
4	Resistors and capacitors	Inspect the resistors and capacitors for cracks, blistering, or other detrimental defects.	None.

5.1-7. Organizational Quarterly Preventive Maintenance Checks and Services Chart

Sequence No.	Item to be inspected	Procedure	References
1	Publications	See that all publications are complete, serviceable, and current.	DA Pam 310-4.
2	Modifications	Check DA Pam 310-4 to determine if new applicable MWO's have been published. All urgent MWO's must be applied immediately. All normal MWO's must be scheduled.	TM 38-750.
3	Spare parts	Check all spare parts (operator and organizational) for general condition and method of storage. There should be no evidence of overstock, and all shortages must be on valid requisitions.	
4	Air filter	Inspect and clean the air filter in accordance with instructions in Section V.	
5	Lubrication	Oil the fan motor in accordance with instructions in Section V.	

5.1-8. Cleaning

Inspect the exterior of the oscilloscope. The exterior surfaces must be free of dust, grease, and fungus.

a. Remove dust and loose dirt with a clean, soft cloth.

Warning: Cleaning compound is flammable and its fumes are toxic. Provide adequate ventilation. DO NOT use near a flame. Avoid contact with the skin; wash off any that spills on your hands.

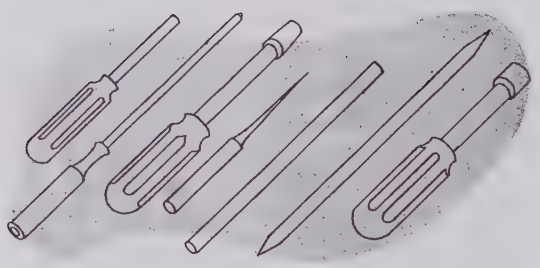
b. Remove grease, fungus, and ground-in dirt from the case and cover of the test set. Use a cloth dampened (not wet) with Cleaning Compound (FSN 7930-395-9542).

c. Remove dust or dirt from plugs and jacks with a brush.

d. Clean the front panel and control knobs with a soft clean cloth. If dirt is difficult to remove, dampen the cloth with water; use mild soap if necessary.

5.1-9. Touchup Painting Instructions

Remove rust and corrosion from metal surfaces by lightly sanding them with fine sandpaper. Brush two thin coats of paint on the bare metal to protect it from further corrosion. Refer to the applicable cleaning and refinishing practices specified in TB SIG 364.



SECTION 6

CALIBRATION PROCEDURE

EQUIPMENT REQUIRED

The following equipment is required for a full recalibration of the Type 543/543A.

1. DC voltmeter (sensitivity at least 5000 Ω/v calibrated for an accuracy of at least 1% at 100, 150, 225, 350 and 500 volts, and for an accuracy of 3% at 1350 volts. Be sure the meter is accurate; few portable meters have comparable accuracy, particularly after a period of use.
2. Accurate rms-reading ac voltmeter, 0-150 volts (0-250 or 0-300 volts for 234-volt operation).
3. Variable autotransformer (Powerstat, Variac, etc.) having a rating of at least 6.25 amperes.
4. Time-Mark Generator, Tektronix Type 180 or Type 180A or equivalent. Time-Mark Generator used must have markers at 1 μsec, 10 msec, 100 msec, 1 sec and 5 sec, and sine-wave output 10 mc and 50 mc, with an accuracy of at least 1%.
5. Constant-Amplitude Signal Generator, Tektronix Type 190 or 190A. Signal Generator used must provide a 200-millivolt signal variable in frequency from 500 kc to over 30 mc. The signal amplitude must remain constant (200 mv) over the entire frequency range.

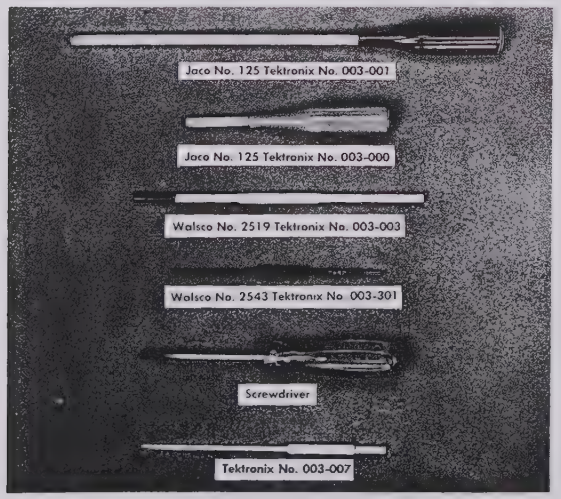

Jaco No. 125 Tektronix No. 003-001
Jaco No. 125 Tektronix No. 003-000
Walsco No. 2519 Tektronix No. 003-003
Walsco No. 2543 Tektronix No. 003-301
Screwdriver
Tektronix No. 003-007

Fig. 6-1. Suggested Calibration tools.

6. Low-Capacitance Recalibration tools: Part numbers 003-000 and 003-007 (See page 11, Accessories Section).
7. Type K Plug-In Unit
   If a Type K Unit is not available, another of the Tektronix preamplifier-type plug-in units may be used. Variations in the Recalibration Procedure, when a Type K unit is not used, are explained at the appropriate time.
8. Type P Plug-In Unit, or a Square-Wave Generator, Tektronix Type 107 or equivalent. The Tektronix Type P Unit is designed especially for adjusting the Delay Line and high frequency compensating circuits in the Type 543/543A. If a Type P Unit is not available, a fast-rise Square-Wave Generator, having a rise time of no more than 3 millimicroseconds, may be used. A B52-R Terminating Resistor is required if the Type 107 or equivalent is used (see page 2, Accessories section).

ADJUSTMENT PROCEDURE

Preliminary

Remove the side covers and the bottom plate from the Type 543/543A and install the Type K (or other type plug-in) unit. Set up the front-panel controls as follows:

Type 543/543A

INTENSITY	full left (ccw)
TRIGGERING MODE	AUTOMATIC
TRIGGER SLOPE	+INT.
TIME/CM	.5 mSEC
VARIABLE	CALIBRATED (full right)
HORIZONTAL DISPLAY	NORMAL (X1)
NORMAL SWEEP/ SINGLE SWEEP	NORMAL SWEEP
CALIBRATOR	OFF

Plug-In Unit

The following controls are those associated with the Type K Plug-In Unit; the nomenclature will differ slightly with other types.

AC/DC	DC
VOLTS/CM	.05
VARIABLE	CALIBRATED (full right)

Note: For those controls not listed, their adjustment is not pertinent to this part of the procedure and the controls may be left in any position. Adjustment of these controls will be made at the appropriate time in the following procedure.

Check the rear panel of the instrument to be sure the ground strap is connected between the GRD. and EXTERNAL CRT CATHODE binding posts, and that the CRT CATHODE SELECTOR switch is turned away from the DUAL-TRACE CHOPPED BLANKING position. Connect the Type 543/543A to the autotransformer, and turn on all equipment. Set the output of the autotransformer to the design center voltage for which your instrument is wired (117 or 234 v). Allow at least five minutes for warmup before making any adjustments.

If the instrument fails to calibrate in any of the following steps, refer to the Troubleshooting Procedure section of the manual for information concerning the circuit involved.

POWER SUPPLY, CALIBRATOR AND CRT CIRCUIT

(1) —150-Volt Adjust

Connect voltmeter to —150-volt bus at the test point indicated on the upper chassis on the right side of the instrument. Adjust the —150 Adj. control for a reading of exactly —150 volts. Use a voltmeter you know to be accurate. Check voltage on +100, +225, +350 and 500-volt buses; all should be within 3% of rated value. If any of the regulated buses that must measure within 3% of its rated value does not measure between these limits, readjust the —150 Adj. control until the voltage measures within specifications. At the final setting of the —150 Adj. control, the —150-volt bus must measure between —147 and —153 volts (± 2%).

Check regulation of each bus by varying line voltage between 105 and 125 volts (or 210 and 250 volts); all regulated voltages should remain constant over this range.

(2) Calibrator

Connect voltmeter to Cal. Test Point (make sure calibrator is turned off). Adjust Cal. Adj. control for reading of +100 volts. Turn CALIBRATOR on (to any output voltage); voltage at test point should fall to +50 ±5 volts.

(3) —1350-Volt Adjust

Connect voltmeter to HV. Adj. Test Point. Adjust HV Adj. control for reading of exactly —1350 volts. (If your voltmeter has a 1200-volt scale, connect common lead of voltmeter to —150-volt bus, and adjust HV Adj. for dial reading of 1200 volts). This voltage should not vary more than 10 volts between the following limits:

Lower limit: Line voltage 105 volts (or 210 volts) INTENSITY control full right.

Upper limit: Line voltage 125 volts (or 250 volts) INTENSITY control full left.

(4) CRT Alignment

Turn up INTENSITY control until trace is visible (it may be necessary to adjust the VERTICAL POSITIONing control on the plug-in unit) and adjust FOCUS and ASTIGMATISM for sharpest trace (narrowest trace width). Position trace directly behind center graticule line. If the trace and graticule line do not coincide over the length of the graticule, loosen the crt base clamp and rotate the tube with the alignment ring. When the trace and the graticule line are in coincidence, push the tube forward so that it rests snugly against the graticule. Then tighten the crt base clamp. Recheck the alignment after tightening the clamp to be sure it didn't move while the clamp was being tightened. Newer scopes have crt rotator knob.

(5) Graticule Alignment

Position the trace directly behind the center graticule line; then using a screwdriver with an insulated handle (or a shorting strap) short the vertical deflection plates together at the neck pins on the crt. These are the plates marked BLUE (UPPER) and BROWN (LOWER). Be careful not to short the pins to the crt shield. Observe the vertical position of the trace on the crt when the vertical deflection plates are shorted together; this is the electrical center of the crt. If the electrical center of the crt does not coincide with the center line of the graticule, remove the short from the deflection plates and position the trace to the electrical center. Remove the graticule cover and loosen the set screw in the nylon cam in the lower left corner of the graticule. Check to be sure the trace is at the electrical center of the crt, and position the center line of the graticule to coincide with the trace. Tighten the set screw in the positioning cam and replace graticule cover.

(6) CRT Geometry

Connect a test lead from the CAL. OUT connector to the INPUT connector on the plug-in unit, and set the CALIBRATOR for an output of .5 volt. Position the display vertically so that only the rising and falling portions of the signal are visible on the crt (it may be necessary to reduce the ambient light to see the trace). Adjust the INTENSITY, FOCUS and ASTIGMATISM controls for best definition; then adjust the Geom. Adj. control for minimum curvature in the vertical traces.

TRIGGERING CIRCUITS

Reset front-panel controls as follows:

Type 543/543A

STABILITY	full right (cw)
TRIGGERING LEVEL	0
TRIGGERING MODE	AC SLOW (AC)
TRIGGER SLOPE	+INT.
TIME/CM	.5 mSEC
VARIABLE	CALIBRATED

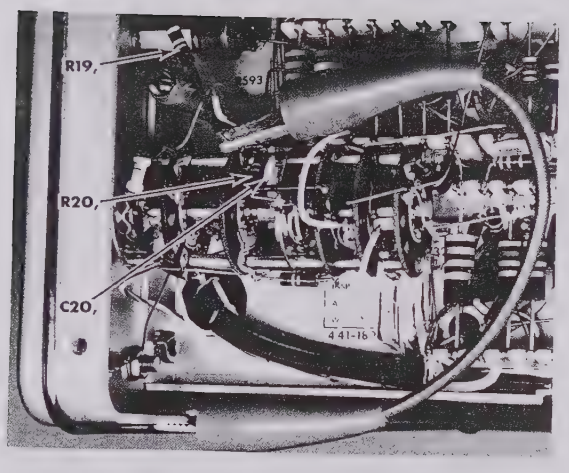


Fig. 6-2. Grounding the junction of R19, R20 and C20 to simplify the adjustment of triggering controls.

HORIZONTAL DISPLAY	NORMAL
NORMAL SWEEP/ SINGLE SWEEP	NORMAL SWEEP
CALIBRATOR	10 MILLI VOLTS

Plug-In Unit

AC/DC	DC
VOLTS/CM	.05
VARIABLE	CALIBRATED

Connect a test lead from the CAL. OUT connector to the INPUT connector on the plug-in unit; this should result in a free-running trace having an amplitude of about 2 millimeters (1 minor division). Center the trace vertically on the screen and adjust the INTENSITY, FOCUS and ASTIGMATISM controls for best definition. Then ground the junction of R19, R20 and C20 with a short clip lead. This junction is located on top of the Trigger switch (see Fig. 6-2).

(7) Triggering Sensitivity and Level

Preset the Trigger Sensitivity control full left (ccw) and the Triggering Level Centering control full right (cw). Turn the STABILITY control left until the trace just disappears from the crt screen, then two or three degrees further left.

Turn the Triggering Level Centering control to the left until the display reappears on the screen. If the display does not appear, turn the Trigger Sensitivity control to the right a few degrees, and repeat the adjustment of the Triggering Level Centering control until the display reappears. Reduce the amplitude of the signal by turning the VARIABLE gain control on the plug-in unit slowly toward the full left position, at the same time continuing the adjustment of the Triggering Level Centering and Trigger Sensitivity controls to keep the trace on the screen.

Then switch the TRIGGER SLOPE control to —INT. and +INT.; it may be necessary to turn the Triggering Level Centering control back to the right a bit to obtain a stable display. Switch the TRIGGER SLOPE control back and forth between —INT. and +INT., each time readjusting the Triggering Level Centering control to obtain a display. Then set the Triggering Level Centering control half way between the settings at which the waveform is stable in the +INT. and —INT. positions (the TRIGGER SLOPE switch may be left in either position) and adjust the Trigger Sensitivity control slowly to obtain a stable display. Then while switching back and forth between +INT. and —INT., slightly readjust both the Triggering Level Centering and Trigger Sensitivity controls for stable triggering in both positions.

(8) Internal Triggering DC Level

Return the VARIABLE gain control to the CALIBRATED position, center the display vertically, and turn the TRIGGERING MODE switch to the DC position. Then, while switching the TRIGGER SLOPE control back and forth between +INT. and —INT., adjust the Int. Trig. DC Level Adj. control for stable triggering in both positions. It may be necessary to slightly adjust the VERTICAL POSITION control to obtain stable triggering.

(9) Preset Stability and Automatic Triggering

Leave setup unchanged from previous step except for the following: Remove the jumper grounding the junction of R19, R20 and C20, remove the test lead connecting the CAL. OUT and vertical INPUT connectors, and set the TRIGGERING MODE switch to the AUTOMATIC position. Set the PRESET ADJUST control (screwdriver adjustment, front panel) to its full left position and connect a voltmeter between the center arm of the PRESET ADJUST potentiometer and ground. Next, advance the PRESET ADJUST control to the right until a trace is just visible on the crt; note voltmeter reading for this setting of the control. Then, advance the PRESET ADJUST control further right until the trace brightens and note the voltmeter reading for this setting. Finally, back off the control until the voltmeter indicates a reading midway between the two previous readings.

TIME-BASE GENERATOR AND HORIZONTAL AMPLIFIER

Set up the Type 543/543A controls as follows:

STABILITY	PRESET
TRIGGERING LEVEL	full right
TRIGGERING MODE	AC SLOW (AC)
TRIGGERING SLOPE	+INT.
TIME/CM	1 mSEC
*VARIABLE	CALIBRATED

HORIZONTAL DISPLAY	X10 SWEEP MAGNIFIED
NORMAL SWEEP/ SINGLE SWEEP	NORMAL SWEEP
CALIBRATOR	OFF

Set up the following oscilloscope and plug-in unit controls for best presentation: FOCUS, INTENSITY, ASTIGMATISM, SCALE ILLUM., HORIZONTAL POSITION, VERTICAL POSITION and VOLTS/CM.

*Make sure the VARIABLE TIME/CM control is locked in the CALIBRATED position for all timing adjustments.

(10) X10 Sweep Magnified Calibration

Apply 100-microsecond markers from the Time-Mark Generator to the INPUT connector of the plug-in unit, and adjust the TRIGGERING LEVEL control for a stable display. Adjust the X10 Cal. control R342 for one marker per centimeter (use the HORIZONTAL POSITION control to align the markers with the graticule lines). The circuit must calibrate between 1- and 9-centimeter graticule lines in steps (10), (11) and (12).

(11) Normal (X1) Calibration

Turn the Horizontal Display switch to the X1 SWEEP position, remove the 100-microsecond markers and apply 1000-microsecond (1 millisecond) markers to the INPUT connector of the plug-in unit. Adjust the X1 Cal. control R368 for one marker per centimeter.

(12) X100 Sweep Magnified Calibration

Turn the Horizontal Display switch to the X100 SWEEP MAGNIFIED position, remove the 1-millisecond markers and apply 10-microsecond markers to the INPUT connector. Adjust the X100 Cal. control R356 for one marker per centimeter.

Repeat steps (10), (11) and (12) as there is interaction between these three controls.

(13) Horizontal DC Shift Compensation

Remove any signal from the INPUT connector of the plug-in unit, leave the TIME/CM control at 1 MILLI SEC and set the HORIZONTAL DISPLAY switch to the X100 SWEEP MAGNIFIED position. Turn the STABILITY control away from the PRESET position toward the right until the sweep freeruns, and adjust the HORIZONTAL POSITION control so that the start of the trace coincides with one of the vertical graticule lines. Slowly turn the trace off and on with the STABILITY control and observe the start of the trace for drive. Adjust the DC Shift control R365 for minimum drift in the start of the trace.

(14) Sweep Length

Set the HORIZONTAL DISPLAY switch to the NORMAL position and free-run the sweep by turning the STABILITY control to the right. Position the trace to the left side of the graticule and adjust the Swp. Length control R176 for a sweep length of 10.5 centimters.

(15) Sweep/Magnifier Registration

Apply 1-millisecond markers to the INPUT connector of the plug-in unit, turn the sweep off with STABILITY control, and turn up the intensity so that a vertical trace is visible at the left side of the graticule; then use the HORIZONTAL POSITION control to position the trace to the horizontal center of the graticule. Set the HORIZONTAL DISPLAY switch to the X100 SWEEP MAGNIFIED position and reposition the trace to the exact horizontal center of the graticule. (The HORIZONTAL POSITION controls will appear extremely sensitive to touch in the X100 position). Then turn the HORIZONTAL DISPLAY switch back to the NORMAL position and adjust the Swp. Mag. Regis. control R359 so that the trace falls exactly under the center graticule line. Repeat this adjustment as necessary to obtain exact coincidence of the trace for both positions of the HORIZONTAL DISPLAY switch.

Set the HORIZONTAL DISPLAY switch to NORMAL, the STABILITY control to PRESET and the INTENSITY control for normal brilliancy. Then obtain a stable display with the TRIGGERING LEVEL control and position the start of the display to the left side of the graticule. Observe the marker that appears in the center of the graticule and position the display, if necessary, so that the center marker is aligned with the center graticule line. Then turn the HORIZONTAL DISPLAY switch to the X100 position and position the marker so that the leading edge is exactly aligned with the center graticule line. Turn the HORIZONTAL DISPLAY switch through all SWEEP MAGNIFIED positions back to NORMAL and observe the leading edge of the marker; it should remain stationary, aligned with the center line of the graticule.

(16) Check Sweep Timing 5 Seconds/cm to .1 Millisecond/cm

Table 6-1, below, lists the time markers to be applied for the indicated setting of the TIME/CM switch and the number of markers per centimeter to be observed for each setting. There are no adjustments to be made in this step; this is a check on the accuracy of the components that make up R160 and C160 in the indicated range of sweep rates.

TABLE 6-1

TIME/CM	TIME MARKERS	OBSERVE
.1 MILLI SEC	100 μsec	1 marker/cm
1 MILLI SEC	1 msec	1 marker/cm
2 MILLI SEC	1 msec	2 marker/cm
5 MILLI SEC	5 msec	1 marker/cm
10 MILLI SEC	10 msec	1 marker/cm
.1 SEC	100 msec	1 marker/cm
1 SEC	1 sec	1 marker/cm
2 SEC	1 sec	2 marker/cm
5 SEC	5 sec	1 marker/cm

(17) Check and Adjust Sweep Timing 50 Microseconds/cm to .1 Microsecond/cm

Reset the following controls to the indicated position:

TRIGGERING MODE	AC FAST (AC LF REJECT)
TRIGGER SLOPE	+EXT.

Connect a lead (preferably coaxial cable) from the trigger-output connector of the Time-Mark Generator to the TRIGGER INPUT connector of the Type 543/543A. Check to see that the VARIABLE TIME/CM control is locked in the CALIBRATED position. Adjust the TRIGGERING LEVEL control as required in the following steps to obtain a stable display.

Table 6-2 lists the time markers of sine-wave frequencies to be applied for the indicated setting of the TIME/CM switch, and the number of markers of cycles to be observed. All SWEEP MAGNIFIED linearity checks should be made at 10% from start of sweep, the center of the sweep and 10% from end of sweep (the 1-, 5- and 9-centimeter points).

Recheck timing from 50 μSEC/CM to .1 μSEC/CM.

(18) Sweep Lockout Level

Reset the following controls to the indicated position.

STABILITY	full left, but not to PRESET
TRIGGERING LEVEL	0
TRIGGER MODE	AC SLOW (AC)
TRIGGER SLOPE	+INT.
TIME/CM	.5 MILLI SEC
HORIZONTAL DISPLAY	NORMAL (X1)
CALIBRATOR	.5 VOLTS
VOLTS/CM (plug-in unit)	.5

Connect a voltmeter to the cathode, pin 7, of V125 and advance the STABILITY control to a point just before the sweep free runs; observe the voltmeter reading at this setting. Set the NORMAL SWEEP/SINGLE SWEEP switch to the SINGLE SWEEP position and trigger the sweep by turning the STABILITY control full right; the READY light should extinguish indicating the sweep is now locked out. Then adjust the Lockout Level Adj. control R125 for a voltmeter reading 11 volts below (less negative) the previous reading.

Return the switch to the NORMAL SWEEP position, connect a test lead between the CAL. OUT connector and the vertical INPUT connector, and adjust the STABILITY and TRIGGERING LEVEL controls for a stable, triggered display. Remove the lead from the INPUT connector, depress the switch to RESET and let it return to SINGLE SWEEP; the READY light should ignite indicating the sweep circuit is armed. Touch the test lead from the CAL. OUT connector to the INPUT connector to produce one sweep; the READY light should extinguish upon completion of the sweep. Then turn the STABILITY control left (ccw) but not to PRESET; the READY light should ignite but the sweep should not trigger. Return switch to NORMAL SWEEP.

(19) External Horizontal Preamplifier Balance

Obtain a free-running trace by turning the STABILITY control full right, and connect a test lead between the vertical INPUT connector and the SAWTOOTH OUT connector (be extremely careful not to ground the SAWTOOTH OUT signal). Turn the HORIZONTAL DISPLAY switch to the EXT. position, and center the vertical trace on the crt with the HORIZONTAL POSITION controls. Adjust the Ext. Horiz. Amp. DC Bal. control R334 for no horizontal shift in trace position as the EXTERNAL HORIZONTAL VARIABLE control is rotated through its range.

(20) External Horizontal Preamplifier Gain

Set controls as follows:

STABILITY	full right
HORIZONTAL DISPLAY	EXT.
EXTERNAL HORIZONTAL VOLTS/CM	.1
VARIABLE	CALIBRATED (full right)
CALIBRATOR	.5 VOLTS

Apply signal from CAL. OUT connector to EXTERNAL HORIZ. IN connector, and adjust the Ext. Horiz. Amp. Cal control R361M (located on top of HORIZONTAL DISPLAY switch) for 5 centimeters of horizontal deflection. Check the 1 and 10 VOLTS/CM positions with 5 volts and 50 volts, respectively, of calibrator signal (deflection should be 5 centimeters for all three positions of switch).

(21) External Horizontal Attenuator Compensation

Set up controls as follows:

Type 543/543A

STABILITY	PRESET
TRIGGERING MODE	AC SLOW (AC)
TRIGGER SLOPE	+EXT.
TIME/CM	.5 MILLI SEC
HORIZONTAL DISPLAY	EXT.
EXTERNAL HORIZONTAL VOLTS/CM	1
VARIABLE	CALIBRATED
CALIBRATOR	5 VOLTS

Plug-In Unit

VOLTS/CM	20

Apply the signal from the CAL. OUT connector to both the EXTERNAL HORIZ. IN connector and the TRIGGER INPUT connector; apply the signal from the SAWTOOTH OUT connector to the vertical INPUT connector (do not

ground the signal from the SAWTOOTH OUT connector). Adjust the TRIGGERING LEVEL control to obtain a stable display of the signal (this will be a vertical display of the calibrator waveform). Adjust C310 for optimum square wave presentation. Turn EXTERNAL HORIZONTAL VOLTS/CM control to 10 and CALIBRATOR to 50 VOLTS, and adjust C313 for optimum square wave presentation.

TABLE 6-2

TIME/CM	SWEEP MAGNIFIED	TIME MARKERS OR SINE WAVE FREQ.	CHECK OR ADJUSTMENT
50 μSEC and .1 MILLI SEC	X1	50 μsec	C337 for same starting position while switching TIME/CM control between settings.
.1 μSEC	X1	10 mc	C160A for timing, C361A for linearity; 1 cycle/cm
10 μSEC	X1	10 μsec	C160E for 1 marker/cm
1 μSEC	X1	1 μsec	C160C for 1 marker/cm
2 μSEC	X1	1 μsec	Resistor check; 2 markers/cm
5 μSEC	X1	1 μsec	Resistor check; 5 markers/cm
2 μSEC	X100	50 mc	C387 and C388, *C378 and C382, and **C394 for linearity and timing; 1 cycle/cm.
1 μSEC	X50	50 mc	Check timing and linearity for 1 cycle/cm.
.5 μSEC	X20	50 mc	Check timing and linearity for 5 cycles over 4 cm.
.2 μSEC	X10	50 mc	† C361G for 1 cycle/cm.
.1 μSEC	X5	50 mc	C361E for 1 cycle/cm.
.1 μSEC	X2	50 mc	C361C for 5 cycles over 2 cm.

* C378 and C382 will normally be adjusted for maximum capacitance.

** On some instruments C394 is a fixed capacitor.

† On some instruments C361G is a fixed capacitor.

VERTICAL AMPLIFIER

Set up front-panels controls as follows:

Type 543/543A

TRIGGERING MODE	AUTOMATIC
TRIGGER SLOPE	+INT.
TIME/CM	.5 MILLI SEC
HORIZONTAL DISPLAY	NORMAL (X1)
CALIBRATOR	100 MILLIVOLTS

Plug-in Unit

AC/DC	DC
VOLTS/CM	.05
VARIABLE	CALIBRATED (full right)

Before proceeding with the calibration of the Vertical Amplifier the dc balance of the plug-in unit should be checked. Rotate the VARIABLE control, if any vertical displacement of the trace is apparent adjust the DC Bal control (accessible through the front panel) until the trace remains stationary as the VARIABLE control is rotated. (On some plug-in units this control is called VARIABLE ATTEN BAL.) Be sure to return the VARIABLE control to the CALIBRATED position after completing the adjustment. IMPORTANT NOTE: Be sure the plug-in unit used for the following adjustment has been correctly calibrated for gain.

(22) Vertical Amplifier Gain

Apply 100 millivolts of signal from the Calibrator to the Vertical INPUT connector. Adjust the Gain Adj. control R1027 for exactly 2 centimeters of vertical deflection. NOTE: This is the Gain Adj. control for the main Vertical Amplifier, not the one for the plug-in unit. The Gain Adj. control R1027 is accessible from the under side of the instrument.

(23) DC Shift Compensation

Remove the Calibrator signal from the Vertical INPUT connector, set the VOLTS/CM control to .5 and position the trace near the bottom line of the graticule. Connect an ohmmeter, set to the R x 1 scale, between the vertical INPUT connector and the chassis. The voltage at the INPUT connector is zero so there is no danger of damaging the meter. If the polarity of the ohmmeter leads is correct, and if a 1½-volt cell is used on the R x 1 scale, the trace should jump toward the upper line of the graticule. If the trace is deflected off the screen it may be necessary to reverse the ohmmeter leads, increase the setting of the VOLTS/CM control, or both. When the proper polarity for the ohmmeter leads has been established, find a setting for the VOLTS/CM control (if other than .5) where the trace is visible on the crt with the ohmmeter both connected and disconnected.

Alternately connect the lead to the INPUT connector and disconnect it, observing the trace as it comes to rest. If there is any vertical drift to the trace, as it comes to rest in either position, adjust the DC Shift control R1091 until the trace remains stationary. This is a very slow drift and must be observed for a few seconds to determine the amount and direction.

DELAY LINE AND HIGH-FREQUENCY COMPENSATION

This section describes two methods for adjusting the Delay Line and high-frequency compensation of the Type 543/543A Oscilloscope. The first and preferable method requires a Tektronix Type P Plug-In Test Unit, which generates a fast-rise step function of known characteristics. This signal simulates the output of an ideally compensated Type K Preamplifier Plug-In Unit driven by a Tektronix Type 107 Square-Wave Generator. The Type P Unit permits the standardization of the main Vertical Amplifier and Delay Line transient response of Type 543/543A (and other Tektronix convertible-type) oscilloscopes. After standardization, the Type 543/543A (or other convertible-type oscilloscope) may be used in conjunction with a Type 107 Square-Wave Generator to standardize the transient response of preamplifier-type plug-ins. Standardized oscilloscopes and plug-in units may then be used interchangeably without readjustment of the high-frequency compensating circuits.

The other method requires a properly adjusted Type K (or other fast-rise, wide-band preamplifier) Plug-In Unit and a Tektronix Type 107 (or equivalent) fast-rise Square-Wave Generator. Unlike the first method, this method is used to compensate the main Vertical Amplifier and Delay Line to match the plug-in unit being used. Depending on the adjustment of the plug-in unit employed, the oscilloscope may or may not be suited for use with other plug-in units, in high frequency applications, if this method is used. This method is entirely satisfactory, however, if the same plug-in unit (the one employed during the adjustment procedure) is used with the oscilloscope.

(24) Method using Type P Plug-In Unit

Install the Type P Unit in the Type 543/543A and position the oscilloscope physically so that either of the UP arrows on the P Unit points upward. Set the front-panel controls as follows:

Type 543/543A

STABILITY	full right
TRIGGERING LEVEL	full right
TRIGGERING MODE	AC FAST (AC LF REJECT)
TRIGGER SLOPE	+INT.
TIME/CM	.2 μSEC
VARIABLE	CALIBRATED
HORIZONTAL DISPLAY	NORMAL (X1)
NORMAL SWEEP/ SINGLE SWEEP	NORMAL SWEEP

Type P Unit

COIL CURRENT	ON
AMPLITUDE	White dot at 3 o'clock

Adjust the COIL CURRENT ADJUST control for the loudest steady hum, and adjust the INTENSITY and VERTICAL POSITION controls so that the two free-running traces are visible on the crt. Then turn the STABILITY control to the PRESET position and advance the INTENSITY control until two spots are just barely visible at the left side of the graticule (it may be necessary to adjust the HORIZONTAL POSITION controls to properly position the spots). Turn the TRIGGERING LEVEL control slowly toward the 0 position until a waveform similar to Fig. 6-3a is obtained. Readjust the AMPLITUDE control for a deflection of about 3 centimeters, adjust the INTENSITY, FOCUS and ASTIGMATISM controls for sharpest detail, and position the waveform as shown in Fig. 6-3.

The unretouched photograph of Fig. 6-3 (a) shows the P-Unit waveform on a properly adjusted Type 543/543A oscilloscope, at a sweep rate of .2 μsec/cm. The flat, level top indicates proper adjustment of the Delay Line and the Termination Network, and the fast rise and square corner indicate proper adjustment of the peaking circuit in the amplifier ahead of the line.

If the P-Unit waveform, when displayed on the Type 543/543A, does not appear as shown in Fig. 6-3 (a), the Delay Line and/or peaking circuits are in need of adjustment.* The following important facts should be remembered when adjusting the circuit:

1. The Delay Line is reverse-terminated. The Delay-Line capacitors nearest the crt will affect the start of the pulse, i.e., the leading corner. The Delay-Line capacitors nearest the Vertical Amplifier will affect the pulse in the region of the termination bump.

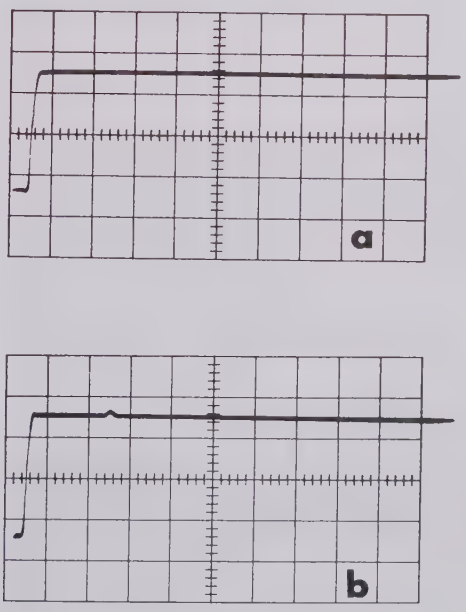


Fig. 6-3. (a) The Type P Unit waveform displayed on a properly adjusted Type 543; (b) the same waveform showing the termination bump.

2. The delay time of the line is 0.2 μseconds; but since the line is reverse-terminated, the termination bump will appear 0.4 μseconds after the corner.
3. The termination bump is affected by the adjustment of the Termination Network, however the Termination Network also affects the corner of the pulse.
4. The peaking adjustments ahead of the Distributed Amplifier and those at the crt deflection plates affect the leading corner of the waveform.

*See also "Waveform Distortion" in the Maintenance section of this manual.

Adjustment Procedure

Minor Adjustment Required

A minor adjustment of the Delay Line and/or peaking circuits will be required when only the leading corner is rounded off or has a slight overshoot (similar to the waveforms shown in Fig. 5-12, page 5-9,) when aberrations appear both at the leading corner and in the vicinity of the termination bump, (see Fig. 5-11 (b), or when there are slight aberrations in the top of the pulse (similar to those shown in Fig. 5-13 (b). By analyzing the type of distortion according to the information presented in the preceding paragraph and that presented in the Troubleshooting Procedure (under Waveform Distortion), it is generally an easy matter to locate the components that have been misadjusted and correct their adjustment.

Major Adjustment Required

A major adjustment of the Delay Line and peaking circuits may be required:

1. If the Delay Line and/or Distributed Amplifier have been replaced;
2. If the instrument has been subjected to severe vibration;
3. If the adjustments have been tampered with.

There are four steps involved in making a major adjustment to the Delay Line and the Vertical Amplifier:

1. Presetting the adjustments;
2. Establishing a level display;
3. Removing the "wrinkles" in the top of the pulse;
4. Compensating the amplifier.

Presetting the Adjustments

If the displayed pulse on the crt indicates that the Delay Line and peaking circuits are considerably out of adjustment, presetting the controls before starting the adjustment procedure will generally render the best results.

The variable inductors in the Vertical Amplifier (L1014, L1024, L1036 and L1046) should be preset so that the slugs are positioned deeper into the coil forms than the windings of the coils extend. The two variable inductors at the crt end of the line (L1354 and L1355) should be preset so that the slugs are just out of the winding. When the slugs are positioned in this manner light can be observed between the slugs and the windings. By presetting the inductors in this manner their effect in the circuit is reduced and the adjustment of the Delay Line is simplified.

The variable capacitors in the delay line should be preset so that the top of the adjusting screw extends about one-quarter of an inch above the top of the contact springs, or if preferred about three-eights of an inch above the body of the capacitor. The important characteristic is that the tops of all the adjusting screws should be at about the same height, both after the preset procedure and after the final adjustment.

The inductors and the capacitors in the termination network are the first to be adjusted in the adjustment procedure; for this reason it is unnecessary to preset these adjustments. However, it is important to check the inductors for balance; the slugs in each inductor should be set to the same depth within the coil form.

Establishing a Level Display

The reference level for the displayed waveform is established by that portion of the pulse following the termination bump. The first step, therefore, is the adjustment of the termination network. Observe the pulse closely about two centimeters to the right of the leading corner, and adjust the three capacitors and two inductors for the minimum termination bump. Be sure to check the inductors for balance as described in the preceding paragraph.

The level of that portion of the pulse preceding the termination bump is determined by the collective effect of all the Delay-Line capacitors. The top of the pulse should be level (not necessarily wrinkle-free at this time); that is, there should be neither an upward nor a downward slant to the top of the pulse between the termination bump and the corner. The level can best be checked by reducing the sweep rate to about 20 μSEC/CM; this reduces the width of the top of the pulse and "crowds" the wrinkles into a smoother display. The reduction in pulse width makes any departure from a level display more easily observed.

To improve the level of the display, start at the terminated end of the line (that is, start with the Distributed Amplifier) and adjust each capacitor a small amount, carefully observing the top of the waveform for the result. Be sure to retain a level top when progressing toward the crt end of the line.

After making the preceding adjustments and establishing an average level for the display, advance the sweep rate to 2 μSEC/CM and repeat the procedure. This time, try to adjust the capacitors for a smooth transition from bump to bump, at the same time maintaining the level. Do not try to obtain a wrinkle-free display at this time; just try to reduce the amplitude of all the bumps the same amount. The important consideration is to retain the level of the display.

Removing the Bumps and Wrinkles

After making the preceding adjustments and reducing the amplitude of the bumps a bit, you can start removing the wrinkles and bumps to a greater degree. Again start at the Distributed Amplifier and work into and through the line to the crt.

Advance the sweep rate to .5 μSEC/CM and adjust the termination network again to reduce the wrinkles in the vicinity of the termination bump. Do not try to achieve a perfectly straight line across the top of the display at this time; just reduce the amplitude of the bumps by about one-half. Then advance to the capacitors in the Distributed Amplifier and adjust them for a reasonably smooth line over that portion of the display they affect. Keep in mind that each capacitor will require only a slight adjustment, and that it is the combined effect of a group of capacitors with which you must be concerned. Then advance to the first group of capacitors in the Delay Line (about four or five) and adjust them in the same manner. As you advance along the line, from one group of capacitors to the next, reduce the sweep rate from time to time to check the level. It is just as important to maintain the level of the display as it is to obtain a wrinkle-free display.

After traversing the entire length of the line, advance the sweep rate to .2 μSEC/CM and repeat the process. Be extremely careful in your adjustments at this time. Any capacitors that require adjustment will need only a slight touch; any overadjustment might nullify all of your effort up to this point. From time to time switch back to a sweep rate of 20 μSEC/CM to check the level.

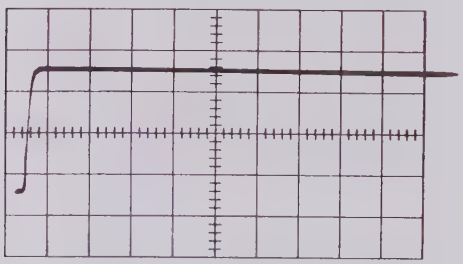


Fig. 6-4. The level, wrinkle-free display indicates proper adjustment of the Delay Line; the rounded corner is due to the fact that the variable inductors in the Vertical Amplifier and at the crt end of the line have not as yet been adjusted from their preset position.

Final Compensation

Upon completing this portion of the adjustment, the display should appear similar to Fig. 6-4. That is, the display should be level and free from aberrations, with a pronounced rolloff at the leading corner. Then adjust the inductors in the Vertical Amplifier and those at the crt end of the line, being careful to adjust any two that make up one pair the same amount. Continue adjusting each pair of inductors, maintaining balance, until the corner begins to square up. This process will introduce some new wrinkles in the display, but these can easily be removed by adjusting the first few capacitors in the Delay Line at the crt end of the line. When the Delay Line and Vertical Amplifier are in proper adjustment, the display should appear similar to Fig. 6-3 (a).

METHOD USING THE TYPE 107 SQUARE-WAVE GENERATOR AND TYPE K PLUG-IN UNIT

Install the Type K Unit (or other type preamplifier) in the Type 543/543A. Connect a B52 R Terminating Resistor to the INPUT connector of the plug-in unit, and connect a 52-ohm coaxial between the Terminating Resistor and the OUTPUT connector of the Type 107.

Set the front-panel controls as follows:

Type 543/543A

STABILITY	full right
TRIGGERING LEVEL	full right
TRIGGER SLOPE	—INT.
TRIGGERING MODE	AC FAST (AC LF REJECT)
TIME/CM	.2 μSEC
VARIABLE	CALIBRATED
HORIZONTAL DISPLAY	NORMAL (X1)
NORMAL SWEEP/ SINGLE SWEEP	NORMAL SWEEP

Type K Unit*

AC/DC	DC
VOLTS/CM	.05
VARIABLE	CALIBRATED

* Set the VOLTS/CM control to the most sensitive DC range for the plug-in unit being used. It is very important to bypass the effect of the attenuators in all plug-in units, and the effect of any ac-coupled preamplifier that some plug-in units employ. Again, make sure that the VOLTS/CM control is set to the most sensitive DC range, and that the VARIABLE control is in the CALIBRATED position.

Type 107

APPROXIMATE FREQUENCY	White dot at 9 o'clock
APPROXIMATE AMPLITUDE	Adjust for 3 centimeters deflection

Adjust the INTENSITY and VERTICAL POSITION controls so that two free-running traces are visible on the crt. Then turn the STABILITY control to PRESET and adjust the TRIGGERING LEVEL control to obtain a stable display. Adjust the HORIZONTAL POSITION control so that the entire positive half-cycle is visible on the crt, and adjust the FOCUS and ASTIGMATISM controls for the sharpest display. The display should then appear similar to Fig. 6-5. From this point the adjustment procedure is identical to that presented for using the Type P Unit.

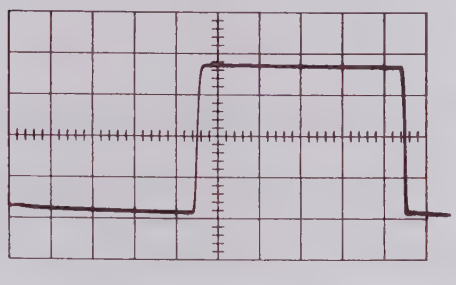


Fig. 6-5. The Type 107 waveform displayed on a properly adjusted Type 543/K-Unit combination; sweep rate: .2 μsec/cm.

(25) Check Bandwidth of Vertical Deflection System

Install a properly calibrated Type K Unit in the Type 543/543A and connect the output cable from the Constant-Amplitude Signal Generator to the INPUT connector of the Type K unit. Set up the front-panel controls as follows:

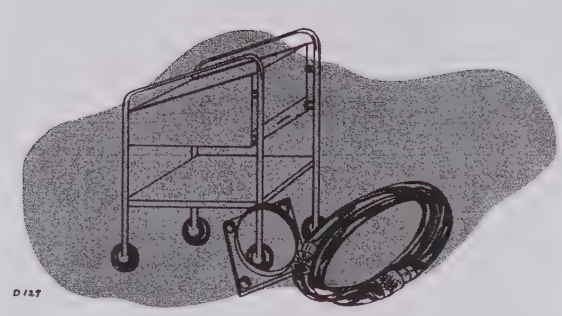
STABILITY	full right
TRIGGERING LEVEL	any position
TRIGGER SLOPE	INT. (+ or —)
TRIGGERING MODE	AC FAST, AC SLOW or DC
TIME/CM	1 MILLI SEC
VARIABLE	CALIBRATED
HORIZONTAL DISPLAY	NORMAL
NORMAL SWEEP/ SINGLE SWEEP	NORMAL SWEEP

Type K Unit

AC/DC	DC
VOLTS/CM	.05
VARIABLE	CALIBRATED

Set the frequency controls on the Signal Generator for an output frequency of 500 kc, and adjust the amplitude controls for a vertical deflection of exactly 4 centimeters. Position the display on the crt (with the VERTICAL POSITION control) so that the deflection extends exactly from the top graticule mark to the bottom graticule mark.

Then increase the output frequency of the Signal Generator to 30 Megacycles (make sure the VOLTS/CM and VARIABLE controls are set to .05 and CALIBRATED, respectively); the deflection should be at least 2.8 centimeters at 30 mc. If not, the Vertical Amplifier and the Delay Line (and possibly the Type K Unit) are in need of further adjustment. For plug-in units other than the K unit the bandpass will be different; see Table 1 in the Specifications section of this manual for the bandpass characteristics of other plug-in units in conjunction with Type 543/543A.



SECTION 7

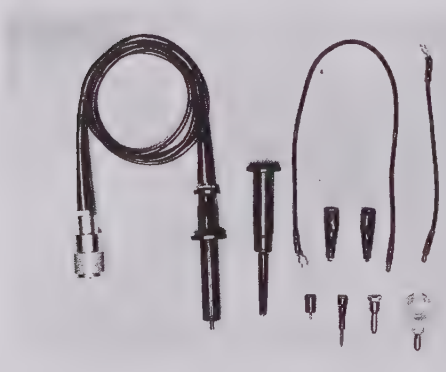
ACCESSORIES

General Information

Your Tektronix instrument has been designed and built to give you maximum performance and versatility. However, for some special applications, there are special accessories available which will increase the versatility of your instrument even more. The accessories which are particularly suited to this instrument are listed in this section.

Accessories should be ordered from your Tektronix Field Engineer or through your nearest Tektronix Field Office by Tektronix part number. Complete, up-to-date price information is also available through your Tektronix Field Engineer or Field Office.

PROBES



P6000 Low-Capacitance High-Performance Probe—The P6000 to P6005 probes preserve the transient response of Tektronix fast-rise, wide-bandpass instruments. These probes are free of overshoot and ringing and have uniform frequency response. They are easy to handle, of rugged construction, and weigh about one ounce. Compensation is accomplished by the rotation of a tubular capacitor; no tools are necessary.

Physical dimensions of the probe body are 7/16 inch in diameter and 3⅝ inches in length without the tip. The standard cable length is 42 inches.

Five interchangeable tips—two straight, one hooked, one pincher, and one banana tip are included with the probe. A 5-inch and a 12-inch ground lead are also included.

PROBE SPECIFICATIONS

Probe & Connector	Cable Length	Atten. Ratio	Input Impedance			Voltage Rating (Max.)
			Resist. Meg Ω	Capacitance—pf		
				Min. *	Max. **	
P6000-UHF P6003-BNC	42 inch 6 foot 9 foot 12 foot	10X	10	11.5 12.5 15.0 17.5	14.5 15.5 18.0 20.0	600
P6001-UHF P6004-BNC	42 inch 6 foot 9 foot 12 foot	1X	1	68 94 120 146	95 121 147 173	600
P6002-UHF P6005-BNC	42 inch 6 foot 9 foot 12 foot	100X	9.1	2.5 2.8 3.5 3.8	2.8 3.25 4.0 4.0	2000

*** When connected to instruments with 20 pf input capacitance.**

**** When connected to instruments with input capacitance up to 50 pf.**

TEKTRONIX PART NUMBERS

	P6000	P6001	P6002	P6003	P6004	P6005
42 inch	010-020	010-023	010-024	010-027	010-028	010-029
6 foot	010-030	010-032	010-034	010-031	010-047	010-050
9 foot	010-035	010-033	010-043	010-045	010-048	010-051
12 foot	010-041	010-042	010-044	010-046	010-049	010-052

P6017 Attenuator Probe—Provides an attenuation of ten times when used with Tektronix oscilloscopes and amplifiers. The P6017 is small and streamlined, and presents an input impedance of 10 megohms paralleled by 14 pf. Probe has a 42" cable with coaxial connector, and is rated at 600 v maximum.

PROBE SPECIFICATIONS

Probe & Connector	Cable Length	Atten. Ratio	Input Impedance: Resist. Meg Ω	Input Impedance: Capacitance—pf Min. *	Input Impedance: Capacitance—pf Max. **	Voltage Rating (Max.)
P6017-UHF	42 inch	10X	10	14	14	600
P6022-BNC	6 foot			17	17	
	9 foot			20	20	
	12 foot			23	23	
P6027-UHF	42 inch	1X	1	67	94	600
P6028-BNC	6 foot			93	120	
	9 foot			120	147	
	12 foot			146	173	

*** When connected to instruments with 20 pf input capacitance.**
**** When connected to instruments with input capacitance up to 50 pf.**

TEKTRONIX PART NUMBERS

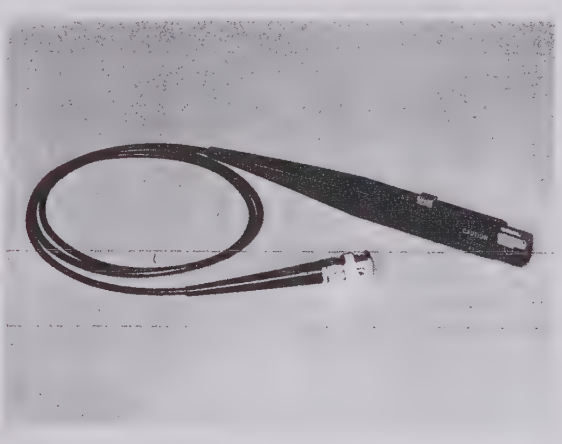
	P6017	P6022	P6027	P6028
42 inch	010-038	010-064	010-070	010-074
6 foot	010-056	010-066	010-071	010-075
9 foot	010-057	010-067	010-072	010-076
12 foot	010-058	010-068	010-073	010-077

P6016 AC Current Probe Systems—The P6016 AC Current Probe and Type 131 Amplifier constitute a current detecting system for use with any wide-band oscilloscope. This system provides accurate displays for observation and measurement of a-c current waveforms. Current range extends from less than one milliampere to 15 amperes. Use of the current probe and amplifier combination will cause risetime and bandpass figures to deteriorate somewhat from those advertised in the manual for the oscilloscope with which the current probe system is being used.

A second system comprises the P6016 AC current probe with a Passive Termination. Although less versatile than the Type 131 amplifier system, the passive termination arrangement does provide slightly better bandpass.

Long narrow shape and convenient thumb control make the P6016 easy to use. Just place probe slot over conductor and close slide with thumb—no direct electrical connection is required. Wiping action keeps core surfaces clean. Loading introduced is so light that it can almost always be disregarded. For increased sensitivity, loop the conductor around the probe slot two or three times.

ORDER PART NUMBER 010-037



The Type P6014 High-Voltage Probe—This new probe provides a means of observing, on an oscilloscope, waveforms of high amplitudes and relatively short duty cycle. DC amplitudes up to 12 kv or short pulses with peak amplitudes up to 25 kv can be measured without damage to the probe.

Attenuation Ratio—1000 to 1.

Frequency Response—dc to over 30 mc.

Input Impedance—10 megohms and 3 pf.

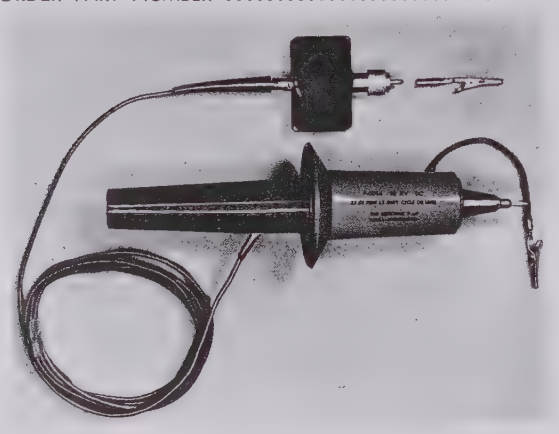
Pulse Rating—10% or less duty cycle with maximum pulse duration of 0.1 sec.

A compensating box on the oscilloscope end enables the P6014 probe to be properly compensated to any oscilloscope having an input capacitance of 20 to 47 pf. The probe introduces no ringing or overshoot.

Probe body length is 12 inches, coaxial cable length is 10 feet.

The probe includes 2 banana-plug tips, an alligator-clip assembly, and an attached 7½ inch ground lead.

ORDER PART NUMBER 010-025



P170CF Cathode-Follower Probe. The cathode-follower tube is a 5718 triode whose cathode load is the 170-ohm termination of the preamplifier grid line in the Type 517. Plate and heater voltages for this tube are provided at a four-terminal socket on the panel of the oscilloscope. The signal is attenuated by 2 times when using the P170CF. The input impedance of the probe will depend on the attenuator head being used, also since transit time in the cathode-follower tube is involved, it will decrease appreciably at the higher frequencies. When the probe is used without an attenuator head, the input looks like 12 megohms shunted by 5 pf. The probe cable is 42" long. Probe complete with 3 attenuator heads

ORDER PART NUMBER 010-101

Replacement Attenuator Heads

PAX-I Attenuator Head for P170CF, attenuation can be varied between 4 times and 40 times.

ORDER PART NUMBER 010-301

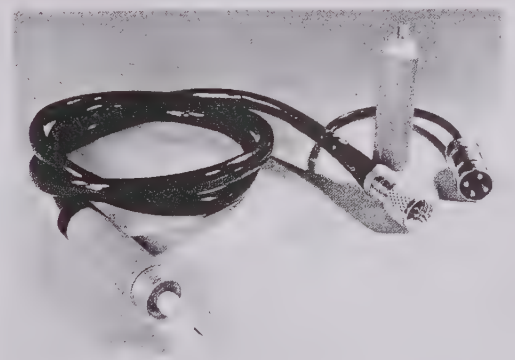
PAX-II Attenuator Head for P170CF, attenuation can be varied between 20 times and 200 times.

ORDER PART NUMBER 010-302

PAX-III Attenuator Head for P170CF, attenuation can be varied between 200 times and 2000 times.

ORDED PART NUMBER 010-303

P500CF Cathode-Follower Probe—Presents low capacitance with minimum attenuation. Input impedance is 40 megohms paralleled by 4 pf, gain 0.8 to 0.85. Input to probe is ac-coupled, limiting its low-frequency response to



5 cycles. Amplitude distortion is less than 3% on unidirectional signals up to 5 volts. 10x attenuator head is included with probe, and should be used on signals exceeding a few volts to minimize amplitude distortion. With the attenuator head attached, the probe input impedance is approximately 10 megohms paralleled by 2 pf. Probe output level is 11 v positive, making it necessary to use the ac-coupled position of the oscilloscope AC-DC switch. Probe cable is 42" long.

ORDER PART NUMBER 010-105

TYPE 128 PROBE POWER SUPPLY

Type 128 Probe Power Supply—For P500CF and P170CF cathode-follower probes. The Type 128 supplies the neces-

sary plate and filament voltages for one or two probes, making it possible to use the cathode-follower probes with oscilloscopes not equipped with a probe-power outlet.

DC Output Voltages:

+120 v regulated, at 25 ma
Two +6.3 v unregulated, at 150 ma

The two cathode-follower probe connections have separate +6.3 v dc voltage supplies.

When a P170CF probe is to be used with an instrument other than the Tektronix Type 517, a 170-ohm terminating resistor is required. The Tektronix 011-016, 170 ohms, 0.5 w Terminating Resistor is recommended for this purpose.

Ripple on the 120 v supply is not more than 5 mv peak-to-peak, and not more than 75 mv peak-to-peak on the 6.3 v supplies.

Power Requirements—105 to 125 v or 210 to 250 v, 50 to 60 cycles, 25 watts using two P500CF probes.

Dimensions—4¾" wide, 7¾" high, 9" overall depth.

Weight—6 lbs.

Includes: 1—3-conductor power cord (161-010)

Probe Power-Cable Extension—A 24" 3-conductor power-cable extension for Tektronix cathode-follower probes. Permits wider separation of the probe power source from the instrument signal input.

ORDER PART NUMBER 012-030

CALIBRATION ACCESSORIES

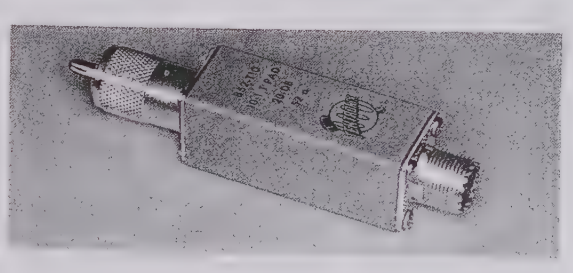
The Type TU-2 Test-Load Plug-In Unit is a convenient special-purpose test tool for the maintenance of Tektronix Type 530, 530A, 540, 540A-Series Oscilloscopes. The unit is used to check power-supply regulation under high load and low load demands of all A to Z plug-in units. It can also

be used to check vertical amplifier balance, vertical amplifier gain, and dual-trace function of the oscilloscope. It eliminates the need to keep plug-in preamplifiers in the maintenance area to make these checks.

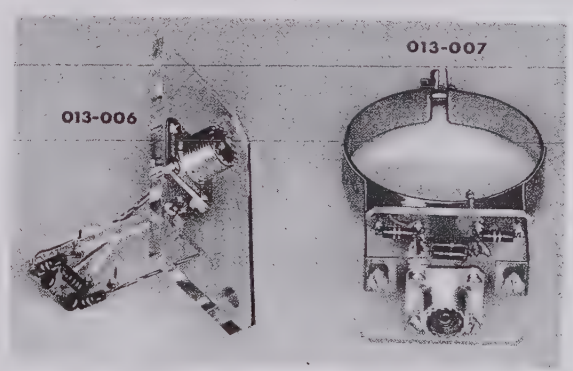
ORDER PART NUMBER 015-012

ATTENUATORS and TERMINATIONS

PART NO.	DESCRIPTION
011-001	52-ohm termination, 1.5 w
011-002	52-ohm 'L' attenuator, 5 to 1 voltage ratio, 1.5 w
011-003	52-ohm 'L' attenuator, 10 to 1 voltage ratio, 1.5 w
011-004	Minimum-loss termination, 52 ohms to 75 ohms
011-005	Minimum-loss termination, 52 ohms to 170 ohms
011-027	52-ohm 'T' attenuator, 5 to 1 voltage ratio, 1.5 w
011-006	52-ohm 'T' attenuator, 10 to 1 voltage ratio, 1.5 w



011-026	52-ohm to 170 ohm termination, 10 to 1 voltage ratio, 1.5 w
011-007	75-ohm termination, 1.5 w
011-008	75-ohm 'L' attenuator, 5 to 1 voltage ratio, 1.5 w
011-009	75-ohm 'L' attenuator, 10 to 1 voltage ratio, 1.5 w
011-010	75-ohm 'T' attenuator, 10 to 1 voltage ratio, 1.5 w
011-011	93-ohm termination, 1.5 w
011-012	93-ohm 'L' attenuator, 5 to 1 voltage ratio, 1.5 w
011-013	93-ohm 'L' attenuator, 10 to 1 voltage ratio, 1.5 w
011-014	Minimum-loss termination, 93 ohms to 52 ohms, 1.5 w
011-015	93-ohm 'T' attenuator, 10 to 1 voltage ratio, 1.5 w
011-016	170-ohm termination, 0.5 w



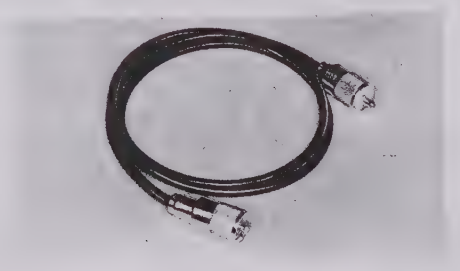
Deflection Plate Connectors—For Type 530, 540, 530A, and 540A-Series Oscilloscopes. A convenient means of making a connection directly to the cathode-ray tube vertical deflection plates to realize the maximum frequency response of the crt. Designed for use with high-frquency, fast-rise pulses or transient signals. Under these conditions

the function of the vertical position control of the oscilloscope is retained. The connectors are designed for use with 52-ohm cables. The connectors are not recommended for use with frequencies below 8 kc or pulses with correspondingly slow risetimes.

For instruments with serial number below 5001,
ORDER PART NUMBER 013-006

For instruments with serial numbers 5001 and above,
ORDER PART NUMBER 013-007

INTERCONNECTING CABLES



52-ohms nominal impedance, 42 inches long.
ORDER PART NUMBER 012-001

75-ohms nominal impedance, 42 inches long.
ORDER PART NUMBER 012-002

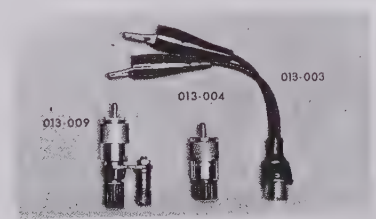
93-ohms nominal impedance, 42 inches long.
ORDER PART NUMBER 012-003

93-ohms, 42 inches long, terminated with variable attenuator.
ORDER PART NUMBER 012-004

93-ohms, 42 inches long, terminated with ½ watt 93 ohm resistor.
ORDER PART NUMBER 012-005

170-ohms nominal impedance, 42 inches long.
ORDER PART NUMBER 012-006

ADAPTERS

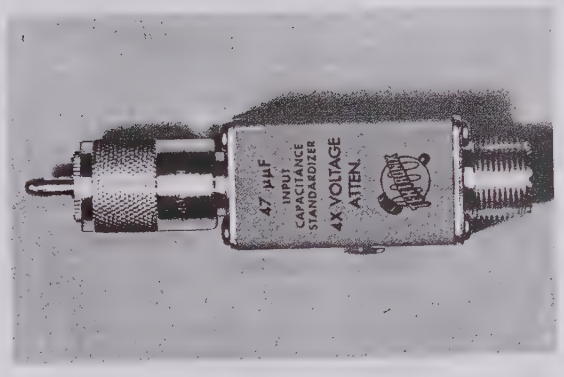


013-003 Adapter, clip lead
013-004 Adapter, binding post
013-009 Binding Post Adapter with ground terminal, ¾" spacing

STANDARDIZERS

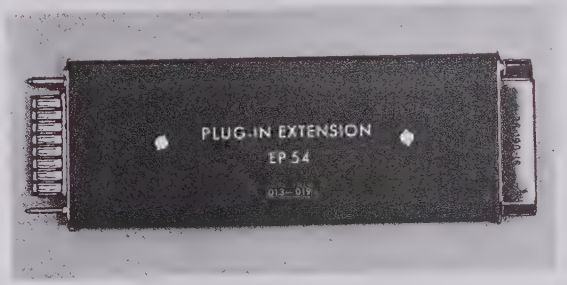
47 pf Input Capacitance Standardizer—For use with Type A to Z Plug-In Preamplifiers having an input capacitance of 47 pf. With this accessory the input capacitance of each preamplifier can be standardized to 47 pf.

ORDER PART NUMBER 011-021



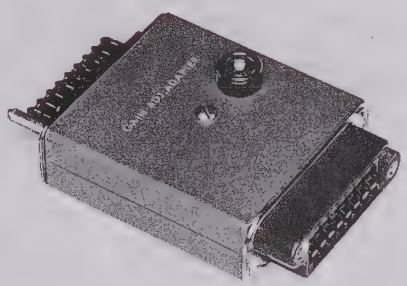
20 pf Input Capacitance Standardizer—Similar to 011-021 for use with the Types CA, K and L Plug-In Preamplifiers having 20 pf input capacitance.

ORDER PART NUMBER 011-022



Plug-in Extension—Six inches long and allows the plug-in preamplifier unit for the Type 530, 530A, 540, 540A-Series Oscilloscopes to be operated partially out of its housing.

ORDER PART NUMBER 013-019



Gain Adjust Adapter—Permits an external calibrating signal to bypass the plug-in preampliifer, for calibrating the sensitivity of the main amplifier of Type 530, 530A, 540, 540A-Series Oscilloscopes.

ORDER PART NUMBER 013-005

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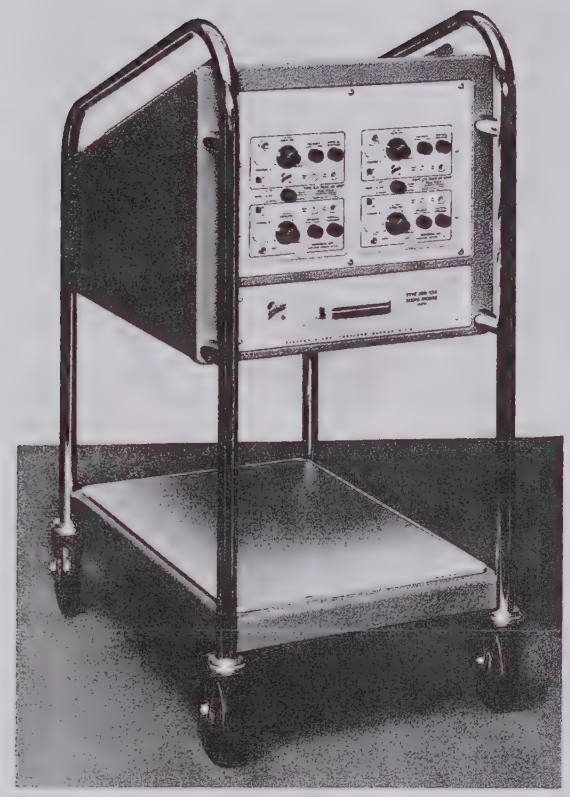
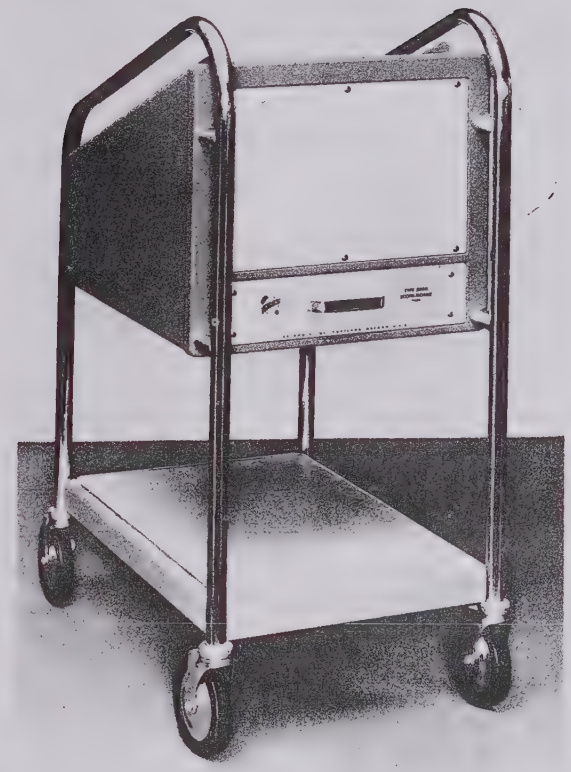
MISCELLANEOUS ACCESSORIES

SCOPEMOBILES





TYPE 500/53A

The Tektronix Type 500/53A Scope-Mobile is a sturdy, mobile support for Tektronix 5" Oscilloscopes. Convenient observation of the crt face is achieved by a 20-degree backward tilt of the top surface. The front panel has two supporting cradles to accommodate Tektronix Preamplifier Plug-In units. A drawer, felt-lined and operating on roller bearings, provides handy storage for probes, cables, manuals etc. An open shelf, 14⅝" wide, 12½" high, and 23⅝" deep, topped with tough linoleum, is located at the bottom. Power input and three convenience outlets are mounted at the rear. Total weight is 35 pounds. Dimensions are 17¾" wide, 38" high and 27" deep. Space requirements for height and depth will vary with the type of instrument being used.

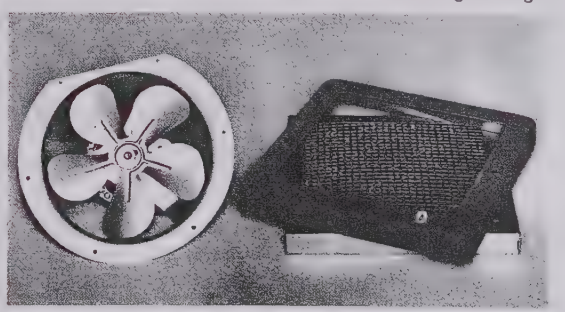
Includes: 1—3-conductor power cord (161-014)

Scope-Mobile Panel—for Type 500A Scope-Mobiles. Converts the Type 500A to a Type 500/53A by replacing the standard blank panel.

ORDER PART NUMBER 014-005

TYPE 500A

The Tektronix Type 500A Scope-Mobile is identical to the Type 500/53A, except for the front panel. Auxiliary equipment can be mounted behind the blank front panel in a space 13¾" wide, and 8½" high for the first 5½" of depth and tapering in height from this point, on a 20 degree angle



Scopemobile fan kit

to a minimum height of 2½" at a depth of 19½". It will usually be necessary to provide forced-air ventilation for the equipment compartment. A fan kit, 040-161, is recommended for this purpose.

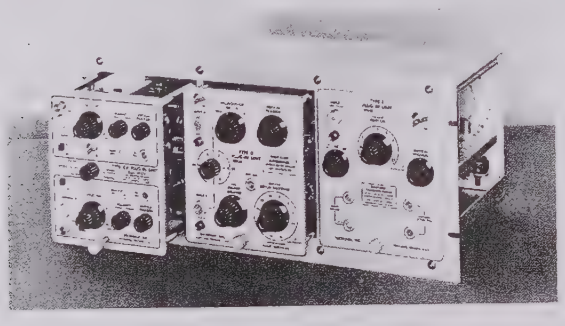
Includes: 1—3-conductor power cord (161-014)

Scope-Mobile Panel—For Type 500 Scope-Mobiles only. Converts the earlier Type 500 model to a Type 500/53 by replacing the standard blank panel.

ORDER PART NUMBER 014-004

Scope-Mobile Fan Kit—for forced-air ventilation of the equipment compartment of the Type 500A Scope-Mobile. Provides an air flow of 84 cfm with the Scope-Mobile drawer in place. With the drawer removed and a panel covering the drawer opening, the air flow is increased to 94 cfm. Contains motor, 5" blade, filter and mounting hardware.

ORDER PART NUMBER 040-161

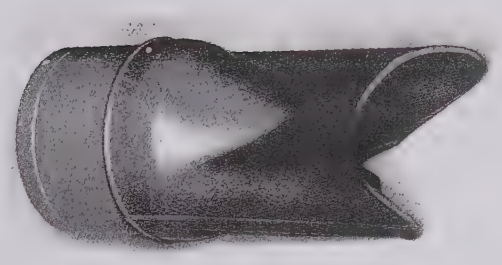


Plug-In Preamplifier Storage Cabinet—Mounts in standard rack, holds three Tektronix Plug-In Preamplifiers. Dimensions: 19" wide, 8¾" high, 9⅜" deep.

ORDER PART NUMBER 437-031

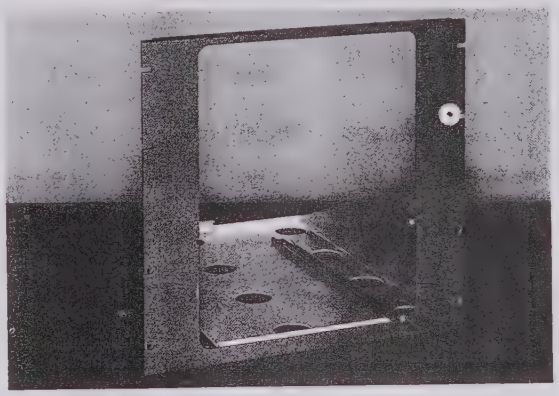
Bezel—For mounting camera on Tektronix 5" oscilloscopes. Dimensions—5⅞" square; ring ⅞"deep, diameter 5⅝" outside, 5⅛" inside. Die-cast construction, wrinkle finish, felt lined.

ORDER PART NUMBER 014-001



Viewing Hood—For Tektronix 5" Oscilloscopes. Includes molded rubber eye-piece and aluminum light shield.

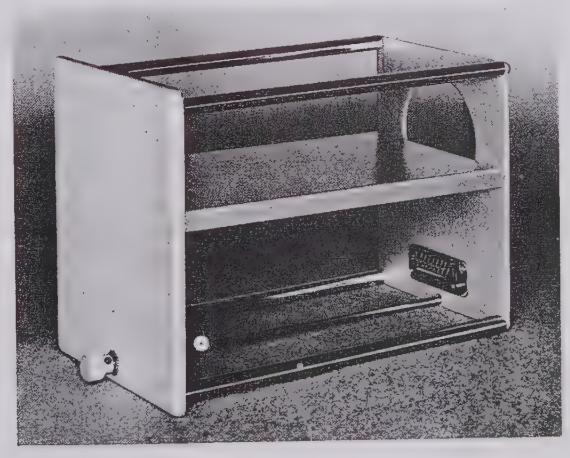
ORDER PART NUMBER 016-001



Cradle-Mount—For rack mounting cabinet-type oscilloscopes. Each cradle-mount consists of a cradle (or "shelf") to support the instrument in any standard 19" relay rack, and a mask to fit over the regular instrument panel. Tek blue wrinkle finish.

For Type 530-series, Type 540-series with serial numbers above 5000, Type 530A-series, Type 540A-series all serial numbers.

ORDER PART NUMBER 040-182



Blank Plug-In Skeleton

ORDER PART NUMBER 040-065

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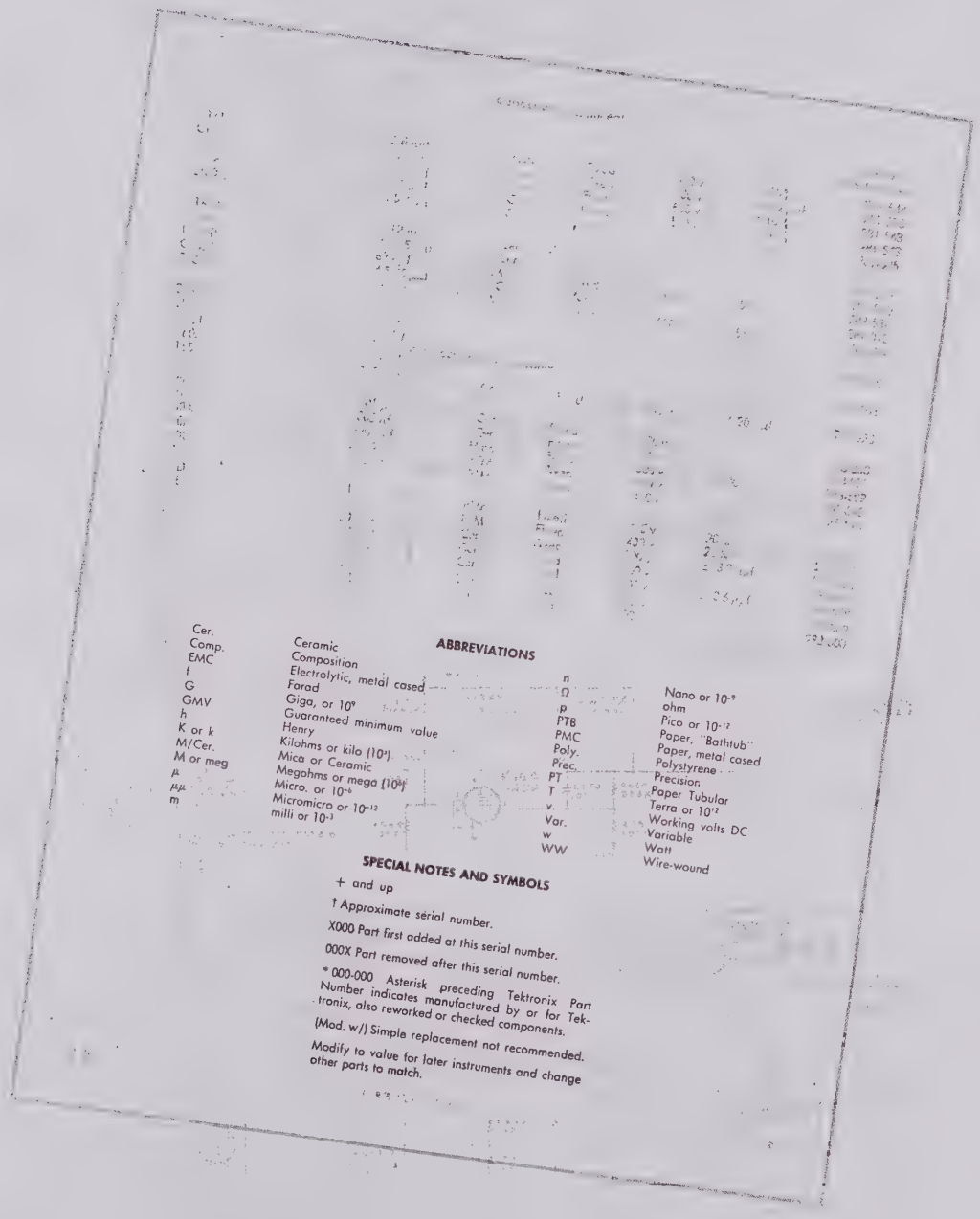
PARTS LIST *and* DIAGRAMS



ABBREVIATIONS

Cer.	Ceramic	n	Nano or 10^{-9}
Comp.	Composition	Ω	ohm
EMC	Electrolytic, metal cased	p	Pico or 10^{-12}
f	Farad	PTB	Paper, "Bathtub"
G	Giga, or 10^{9}	PMC	Paper, metal cased
GMV	Guaranteed minimum value	Poly.	Polystyrene
h	Henry	Prec.	Precision
K or k	Kilohms or kilo (10^{3})	PT	Paper Tubular
M/Cer.	Mica or Ceramic	T	Terra or 10^{12}
M or meg	Megohms or mega (10^{6})	v.	Working volts DC
μ	Micro. or 10^{-6}	Var.	Variable
μμ	Micromicro or 10^{-12}	w	Watt
m	milli or 10^{-3}	WW	Wire-wound

SPECIAL NOTES AND SYMBOLS

+ and up

† Approximate serial number.

X000 Part first added at this serial number.

000X Part removed after this serial number.

* 000-000 Asterisk preceding Tektronix Part Number indicates manufactured by or for Tektronix, also reworked or checked components.

(Mod. w/) Simple replacement not recommended. Modify to value for later instruments and change other parts to match.

HOW TO ORDER PARTS

Replacement parts are available through your local Tektronix Field Office.

Improvements in Tektronix instruments are incorporated as soon as available. Therefore, when ordering a replacement part it is important to supply the part number including any suffix, instrument type, serial number, plus a modification number where applicable.

If the part you have ordered has been improved or replaced, your local Field Office will contact you if there is a change in part number.

PARTS LIST
Type 543, SN 101-3000; 543A, SN 3001-up.

Values are fixed unless marked Variable.

Bulbs

Ckt. No.	S/N Range	Description		Tektronix Part Number
B129		Neon, Type NE-23	READY	Use 150-027
B160Z		Neon, Type NE-23		Use 150-027
B167		Neon, Type NE-23		Use 150-027
B170		Neon, Type NE-23		Use 150-027
B361Y		Neon, Type NE-23	UNCALIBRATED	Use 150-027
B361Z		Neon, Type NE-23	ON	Use 150-027
B380		Neon, Type NE-23		Use 150-027
B390		Neon, Type NE-23		150-001
B601	X3001-up	Graticule Light, Type 47		150-001
B602	X3001-up	Graticule Light, Type 47		150-001
B603	X3001-up	Pilot Light, Type 47		150-001
B700	101-3000X	Pilot Light, Type 47		150-001
B701	101-3000X	Graticule Light, Type 47		150-001
B702	101-3000X	Graticule Light, Type 47		Use 150-027
B1083		Neon, Type NE-23		Use 150-027
B1087		Neon, Type NE-23		

Capacitors

Tolerance ±20% unless otherwise indicated.

C1		4.7 μμf	Cer.	500 v	±1 μμf	281-501
C2	X4490-up	.02 μf	Discap	600 v		283-006
C10	101-460	.0047 μf	PTM	400 v		285-506
	461-1679	.0047 μf	PTM	400 v		Use 285-543
	1680-up	.0022 μf	PTM	400 v		285-543
C11		100 μμf	Cer.	350 v		281-523
C15		.001 μf	Discap	500 v		283-000
C20		.001 μf	Discap	500 v		283-000
C27		47 μμf	Cer.	500 v		281-518
C32		.01 μf	PTM	400 v		285-510
C37		.005 μf	Discap	500 v		283-001
C42		22 μμf	Cer.	500 v		281-510
C116		.001 μf	Discap	500 v		283-000
C117	101-3000	.005 μf	Discap	500 v		283-001
	3001-up	.001 μf	Discap	500 v		283-000
C121	101-3000X	270 μμf	Cer.	500 v	±10%	281-543
C122	X3001-up	470 μμf	Cer.	500 v		281-525
C124	101-3000	8 μμf	Cer.	500 v	±0.5 μμf	281-503
	3001-up	10 μμf	Cer.	500 v	±10%	281-504
C129		.005 μf	Discap	500 v		283-001
C131		27 μμf	Cer.	500 v		281-513
C134	X3001-up	8 μμf	Cer.	500 v	±0.5 μμf	281-503
C138		.005 μf	Discap	500 v		283-001
C141	101-3000	12 μμf	Cer.	500 v	±10%	281-506
	3001-up	8 μμf	Cer.	500 v	±0.5 μμf	281-503
C149		.005 μf	Discap	500 v		283-001

Capacitors *(continued)*

							Tektronix Part Number
C150		82 μμf	Cer.		500 v	±10%	281-528
C158	101-300	27 μμf	Cer.		500 v		281-513
	301-up	12 μμf	Cer.		500 v	±10%	281-506
C160A		3-12 μμf	Cer.	Var.			281-007
C160B		82 μμf	Mica		500 v	±5%	283-534
C160C		4.5-25 μμf	Cer.	Var.			281-010
C160D		82 μμf	Mica		500 v	±5%	283-534
C160E		4.5-25 μμf	Cer.	Var.			281-010
C160F		.001 μf	Mylar			±½%	*291-008
C160G		.01 μf					
C160H		.1 μf		Mylar Timing Series		±½%	*291-007
C160J		1 μf					
C160K	X3610-up	270 μμf	Cer.		500 v		281-543
C165		82 μμf	Cer.		500 v	±10%	281-528
C167		.001 μf	Discap		500 v		283-000
C174		27 μμf	Cer.		500 v		281-513
C180A		220 μμf	Mica		500 v	±10%	283-536
C180B		.0022 μf	PTM		400 v		285-543
C180C		.022 μf	PTM		400 v		285-515
C180D		.1 μf	PTM		400 v		285-526
C180E		.1 μf	PTM		400 v		285-526
C181	101-3000	39 μμf	Cer.		500 v	±10%	281-517
	3001-up	27 μμf	Cer.		500 v	±1.35 μμf	281-515
C191		.001 μf	Discap		500 v		283-000
C195	101-3000	12 μμf	Cer.		500 v	±10%	281-506
	3001-up	15 μμf	Cer.		500 v	±10%	281-509
C198		.005 μf	Discap		500 v		283-001
C310		7-45 μμf	Cer.	Var.			281-012
C311		330 μμf	Mica		500 v	±10%	283-518
C312		27 μμf	Cer.		500 v	±10%	281-512
C313		3-12 μμf	Cer.	Var.			281-007
C314		500 μμf	Mica		500 v	±5%	283-523
C331		.005 μf	Discap		500 v		283-001
C337		4.5-25 μμf	Cer.	Var.			281-010
C339		39 μμf	Cer.		500 v	±10%	281-516
C361A	101-747	3-12 μμf	Cer.	Var.			281-036
	748-up	1.5-7 μμf	Cer.	Var.			281-034
C361C	101-747	5-25 μμf	Cer.	Var.			281-011
	748-up	3-12 μμf	Cer.	Var.			Use 281-036
C361E		8-50 μμf	Cer.	Var.			281-022
C361G	101-747	68 μμf	Cer.		500 v	±10%	281-549
	748-up	8-50 μμf	Cer.	Var.			281-022
C361J	101-747	120 μμf	Cer.		500 v	±10%	281-550
	748-up	8-50 μμf	Cer.	Var.			281-022
C361K	101-747	390 μμf	Cer.		500 v		281-551
	748-up	100 μμf	Cer.		350 v		281-523
C361L		470 μμf	Cer.		500 v		281-525
C361M	X3001-up	47 μμf	Cer.		500 v	±10%	281-519
C361N	X3001-up	47 μμf	Cer.		500 v	±10%	281-519
C364		8 μf	EMT		450 v	−10%+50%	290-094
C365		.01 μf	Discap		150 v		283-003
C378		8-50 μμf	Cer.	Var.			281-022
C382		8-50 μμf	Cer.	Var.			281-022
C385	X398-up	.005 μf	Discap		500 v		283-001

Capacitors *(continued)*

						Tektronix Part Number
C387		.7-3 μμf	Tub.	Var		281-027
C388		.7-3 μμf	Tub.	Var.		281-027
C391		.02 μf	Discap.		150 v	283-004
C394	101-747	1.5 μμf	Cer.		500 v ±0.5 μμf	281-526
	748-up	1.5-7 μμf	Cer.	Var.		281-034
C395		470 μμf	Cer.		500 v	281-525
C601	X3001-up	.1 μf	Discap		500 v	283-008
C610	X3001-up	.01 μf	PTM		400 v	285-510
C617	X3001-up	.01 μf	PTM		400 v	285-510
C628	X3001-up	.01 μf	PTM		400 v	285-510
C640	X3001-up	125 μf	EMC		350 v −10%+100%	290-044
C648	X3001-up	.01 μf	Discap		500 v	283-002
C649	X3001-up	2 x 40 μf	EMC		250 v −10%+100%	290-040
C650	X3001-up	.01 μf	PTM		400 v	285-510
C670	X3001-up	150 μf	EMC		250 v −10%+100%	290-048
C671	X3001-up	150 μf	EMC		250 v −10%+100%	290-048
C672	101-3000X	330 μμf	Mica		500 v ±10%	283-518
C673	101-3000X	330 μμf	Mica		500 v ±10%	283-518
C679A,B,C	X3001-up	3 x 10 μf	EMC		450 v −10% +50%	290-033
C680	X3001-up	.01 μf	PTM		400 v	285-510
C682	101-3000X	27 μμf	Cer.		500 v	281-513
C688	X3001-up	.01 μf	PTM		400 v	285-510
C695	101-3000X	.001 μf	Discap		500 v	283-000
C700	101-3000	.02 μf	Discap		150 v	283-004
	3001-up	125 μf	EMC		450 v −10% +50%	290-045
C707	101-3000X	.01 μf	PTM		400 v	285-510
C710	X3001-up	.01 μf	PTM		600 v	285-511
C711	101-3000X	.01 μf	PTM		600 v	285-511
C715	101-3000X	2 x 40 μf	EMC		250 v −10%+100%	290-040
C717	101-3000X	.01 μf	PTM		400 v	285-510
C720	101-3000X	.01 μf	Discap		500 v	283-002
C730	X3001-up	125 μf	EMC		350 v −10%+100%	290-044
C732	101-3000X	125 μf	EMC		350 v −10%+100%	290-044
C740	101-3000	150 μf	EMC		250 v −10%+100%	290-048
	3001-up	.01 μf	PTM		400 v	285-510
C741	101-3000X	150 μf	EMC		250 v −10%+100%	290-048
C750	101-3000X	.01 μf	PTM		400 v	285-510
C751A,B,C	101-3000X	3 x 10 μf	EMC		450 v −10%+50%	290-033
C752A,B		2 x 1000 μf	EMC		15 v −10%+250%	290-050
C756	101-3000X	125 μf	EMC		450 v −10%+50%	290-045
C760A,B	X3001-up	2 x 40 μf	EMC		450 v −10%+50%	290-042
C763	101-3000X	.01 μf	PTM		400 v	285-510
C770	101-3000X	.01 μf	PTM		400 v	285-510
C780	101-3000X	125 μf	EMC		350 v −10%+100%	290-044
C787	101-1219	.01 μf	PTM		400 v	Use 285-511
	1220-3000X	.01 μf	PTM		600 v	285-511
C790A,B	101-3000X	2 x 40 μf	EMC		450 v −10%+50%	290-042
C797	101-3000X	.01 μf	PTM		400 v	285-510
C800		.047 μf	PTM		400 v	285-519
C803		.001 μf	PTM		600 v	285-501
C805		.01 μf	PTM		400 v	285-510

						Tektronix Part Number
C806		.001 μf	PTM	600 v		285-501
C807		2 x 20 μf	EMC	450 v	−10%+50%	290-037
C814	101-1679	.0068 μf	PTM	3000 v		285-508
	1680-up	.01 μf	Discap	2000 v		283-011
C815		.02 μf	Discap	600 v		Use 283-006
C820	101-1679	.0068 μf	PTM	3000 v		285-508
	1680-up	.01 μf	Discap	2000 v		283-011
C821	101-1530	.0068 μf	PTM	5000 v		Use 283-034
	1531-up	.005 μf	Discap	4000 v		283-034
C822	101-1402	470 μμf	PTM	10,000 v		Use 281-556
	1403-up	500 μμf	Cer.	10,000 v		281-556
C823	101-1402	470 μμf	PTM	10,000 v		Use 281-556
	1403-up	500 μμf	Cer.	10,000 v		281-556
C825	101-1402	470 μμf	PTM	10,000 v		Use 281-556
	1403-up	500 μμf	Cer.	10,000 v		281-556
C828	X3001-up	0.1 μf	Discap	200 v		Use 283-057
C829	X3001-up	470 μμf	Cer.	500 v		281-525
C830	101-1679	.0068 μμf	PTM	3000 v		285-508
	1680-up	.01 μf	Discap	2000 v		283-011
C832	101-1429	.015 μf	PTM	3000 v		285-513
	1430-up	.01 μf	Discap	2000 v		283-011
C834	101-1429	.015 μf	PTM	3000 v		285-513
	1430-up	.01 μf	Discap	2000 v		283-011
C835	X1430-up	.01 μf	Discap	2000 v		283-011
C836	X3001-up	.001 μf	Discap	500 v		283-000
C841		.005 μf	Discap	500 v		283-001
C855	101-1429	.015 μf	PTM	3000 v		285-513
	1430-up	.01 μf	Discap	2000 v		283-011
C857	101-1429	.015 μf	PTM	3000 v		285-513
	1430-up	.01 μf	Discap	2000 v		283-011
C871	X3001-up	330 μμf	Mica	500 v	±10%	283-518
C874	X3001-up	330 μμf	Mica	500 v	±10%	283-518
C885	X3001-up	27 μμf	Cer.	500 v		281-513
C897	X3001-up	.001 μf	Discap	500 v		283-000
C1003		2 x 20 μf	EMC	450 v	−10%+50%	290-036
C1005A		40 μf				
C1005B		20 μf	EMC	475 v		290-063
C1005C		10 μf				
C1007		.1 μf	PTM	400 v		285-526
C1013		.005 μf	Discap	500 v		283-001
C1024		.005 μf	Discap	500 v		283-001
C1029		.001 μf	Discap	500 v		283-000
C1031		.005 μf	Discap	500 v		283-001
C1033		.005 μf	Discap	500 v		283-001
C1034		.005 μf	Discap	500 v		283-001
C1039		.001 μf	Cer.	500 v	±10%	281-536
C1049		.001 μf	Cer.	500 v	±10%	281-536
C1052		.001 μf	Discap	500 v		283-000
C1054		.005 μf	Discap	500 v		283-001
C1056		150 μμf	Cer.	500 v		281-524

Capacitors *(continued)*

						Tektronix Part Number
C1062	.001 μf	Discap		500 v		283-000
C1075	8-50 μμf	Cer.	Var.			281-022
C1077	8-50 μμf	Cer.	Var.			281-022
C1078	.7-3 μμf	Tub.	Var.			281-027
C1085	.005 μf	Discap		500 v		283-001
C1089	.005 μf	Discap		500 v		283-001
C1093A,B	2 x 75 μf	EMC		150 v	−10%+100%	290-071
C1093C,D	2 x 75 μf					
C1102	.001 μf	Discap		500 v		283-000
C1104	.7-3 μμf	Tub.	Var.			281-027
C1105	150 μμf	Cer.		500 v		281-524
C1106	150 μμf	Cer.		500 v		281-524
C1112	.001 μf	Discap		500 v		283-000
C1122	.001 μf	Discap		500 v		283-000
C1124	.7-3 μμf	Tub.	Var.			281-027
C1126	150 μμf	Cer.		500 v		281-524
C1132	.001 μf	Discap		500 v		283-000
C1142	.001 μf	Discap		500 v		283-000
C1144	.7-3 μμf	Tub.	Var.			281-027
C1146	150 μμf	Cer.		500 v		281-524
C1152	.001 μf	Discap		500 v		283-000
C1162	.001 μf	Discap		500 v		283-000
C1164	.7-3 μμf	Tub.	Var.			281-027
C1166	150 μμf	Cer.		500 v		281-524
C1172	.001 μf	Discap		500 v		283-000
C1182	.001 μf	Discap		500 v		283-000
C1184	.7-3 μμf	Tub.	Var.			281-027
C1186	150 μμf	Cer.		500 v		281-524
C1192	.001 μf	Discap		500 v		283-000
C1202	.001 μf	Discap		500 v		283-000
C1204	.7-3 μμf	Tub.	Var.			281-027
C1205	150 μμf	Cer.		500 v		281-524
C1208	.005 μf	Discap		500 v		283-001
C1212	.001 μf	Discap		500 v		283-000
C1223	.001 μf	Discap		500 v		283-000
C1224	.005 μf	Discap		500 v		283-001
C1228	.022 μf	PTM		600 v		285-517
C1301-50	.7-3 μμf	Tub.	Var.			(50) 281-027
C1360-75	1.5 μμf	Cer.		500 v	±0.25 μμf	(16) 281-529
C1380	.68 μμf	Cer.		500 v	±.136 μμf	281-537
C1381	.68 μμf	Cer.		500 v	±.136 μμf	281-537
C1382	1 μμf	Cer.		500 v		281-538
C1384	.68 μμf	Cer.		500 v	±.136 μμf	281-537
C1385	.68 μμf	Cer.		500 v	±.136 μμf	281-537

Diodes

*Even though the diodes may be different in physical size, they are direct electrical replacements for the diodes in your instrument.

D131	X3001-up	Germanium Diode	152-008
D642A,B,C,D	X3001-up	Silicon Diode	152-047
D672A,B,C,D	X3001-up	Silicon Diode	152-047
D679	X3090-up	Silicon Diode	152-047
D702A,B	X3001-up	Silicon Diode	152-047
D732A,B	3001-up	Silicon Diode	152-047
D732A,B,C,D	X950-3000	Silicon Diode	Use 152-047
D740A,B,C,D	X950-3000X	Silicon Diode	Use 152-047
D752A,B	X950-up	Silicon Diode	Use 152-047
D756A,B,C,D	X950-3000X	Silicon Diode	Use 152-047

Diodes (continued)

			Tektronix Part Number
D762A,B,C,D	X3001-up	Silicon Diode	152-047
D780A,B,C,D	X950-3000X	Silicon Diode	Use 152-047
D790A,B,C,D	X950-3000X	Silicon Diode	Use 152-047

Fuses

F601	X3001-up	6 Amp 3 AG Fast-Blo 117 V operation 60 cycle	159-013
		6.25 Amp 3 AG Slo-Blo 117 V operation 50 cycle	159-011
		3 Amp 3 AG Fast-Blo 234 V operation 60 cycle	159-015
		3 Amp 3 AG Slo-Blo 234 V operation 50 cycle	159-005
F701	101-3000X	6 Amp 3 AG Fast-Blo 117 V operation 60 cycle	159-013
		6.25 Amp 3 AG Slo-Blo 117 V operation 50 cycle	159-011
		3 Amp 3 AG Fast-Blo 234 V operation 60 cycle	159-015
		3 Amp 3 AG Slo-Blo 234 V operation 50 cycle	159-005
F1054	X3200-up	.15 Amp Slo-Blo 150 ma	159-049

Inductors

L133	101-3000X	88 μh		*108-022
LR149		1 mh		*108-058
L1014	101-318	1.7-3.7 μh	Var.	*114-088
	319-up	1.8-3.9 μh	Var.	*114-112
L1015	X660-up	.45 μh		*108-062
L1024	101-318	1.7-3.7 μh	Var.	*114-088
	319-up	1.8-3.9 μh	Var.	*114-112
L1025	X660-up	.45 μh		*108-062
L1036	101-318	.5-1 μh	Var.	*114-087
	319-up	.3-.55 μh	Var.	*114-111
L1046	101-318	.5-1 μh	Var.	*114-087
	319-up	.3-.55 μh	Var.	*114-111
L1064	101-599	14 μh		*108-134
	600-up	8.4 μh		*108-157
L1071		.3-.5 μh	Var.	*114-092
L1073		.3-.5 μh	Var.	*114-092
L1103		Grid Line 6-section		*108-145
L1104		Plate Line 7-section		*108-139
L1113		Grid Line 6-section		*108-145
L1114		Plate Line 7-section		*108-139
L1304		Delay Line 30-section		Use *108-177
L1305		Delay Line 30-section		Use *108-177
L1334		Delay Line 20-section		Use *108-176
L1335		Delay Line 20-section		Use *108-176
L1354		.9-1.6 μh	Var.	*114-038
L1355		.9-1.6 μh	Var.	*114-038

Rectifiers †

SR732	101-949X	5 plates/leg	*106-012
SR740	101-949X	5 plates/leg	*106-013
SR752	101-949X	1 plate/leg	*106-038
SR756	101-949X	4 plates/leg	*106-019
SR780	101-949X	4 plates/leg	*106-014
SR790	101-949X	5 plates/leg	*106-015

† S/N 950 up, See V732, V740, V752, V756, V780, V790.

A Kit is available to convert from Selemium Rectifiers to Silicon Diodes, Order Mod Kit #040-240.

Relays

			Tektronix Part Number
K600	X3001-up	45 sec. Thermal time delay tube	148-002
K601	X3001-up	DC Relay	148-016
K700	101-3000X	45 sec. Thermal time delay tube	148-002
K701	101-3000X	6 v 4 pole 2 throw	148-004

Resistors

Resistors are fixed, composition, ±10% unless otherwise indicated.

R1		1 meg	½ w	5%	301-105
R2		390 k	½ w	5%	301-394
R3		50 k	2 w	Var.	Int. Trig. DC Level Adj. 311-023
R4		100 k	½ w		302-104
R5	X4490-up	10 meg	½ w		302-106
R12		1 meg	½ w		302-105
R13		100 k	½ w		302-104
R15		470 k	½ w		302-474
R17 †		100 k	½ w	Var.	TRIGGERING LEVEL 311-096
R18		22 k	½ w		302-223
R19		470 k	½ w		302-474
R20	101-300	470 k	½ w		302-474
	301-up	56 k	½ w		302-563
R21	101-300X	56 k	½ w		302-563
R23		33 k	2 w		306-333
R24		39 k	2 w		306-393
R25		47 Ω	½ w		302-470
R26		47 Ω	½ w		302-470
R27		4.7 k	1 w		304-472
R29		4.7 k	1 w		304-472
R32		47 k	½ w		302-473
R33		47 k	½ w		302-473
R34		47 Ω	½ w		302-470
R35	101-300	22 k	2 w		306-223
	301-up	18 k	1 w		304-183
R37		500 Ω	2 w	Var.	Trigger Sensitivity 311-005
R38	101-300	22 k	2 w		306-223
	301-up	18 k	1 w		304-183
R39		100 k	2 w	Var.	Triggering Level Centering 311-026
R40	101-300	100 k	½ w		302-104
	301-up	120 k	½ w		302-124
R41		2.7 meg	½ w		302-275
R42		100 k	½ w		302-104
R44	101-300	2.7 k	½ w		302-272
	301-up	1.5 k	½ w		302-152
R45		1 meg	½ w		302-105
R46	101-300	1 k	½ w		302-102
	301-up	680 Ω	½ w		302-681
R47		47 Ω	½ w		302-470
R48		1.5 k	½ w		302-152
R110 †		100 k	½ w	Var.	STABILITY 311-096
R111	101-1839	100 k	.2 w	Var.	Use 311-219
	1840-up	200 k	.2 w	Var.	PRESET ADJ. 311-219
R114		470 k	½ w		5% 301-474
R115		100 k	½ w		5% 301-104
R116	101-3000	200 k	½ w		5% 301-204
	3001-up	180 k	½ w		5% 301-184

† R17 concentric with SW110 and R110. Furnished as a unit.

						Tektronix Part Number
R117	X519-3000	47 Ω	½ w			302-470
	3001-up	1 k	½ w			302-102
R118	101-3000	10 meg	½ w			302-106
	3001-up	4.7 meg	½ w			302-475
R120	X3001-up	270 k	½ w		5%	301-274
R121		100 Ω	½ w			302-101
R122		22 k	½ w			302-223
R123	X3001-up	470 k	½ w		5%	301-474
R124		100 k	½ w		5%	301-104
R125		50 k	.1 w	Var.	Lockout Level Adj.	311-078
R126	101-3000X	300 k	½ w		5%	301-304
R127		100 Ω	½ w			302-101
R128		12 k	½ w			302-123
R129		27 k	½ w			302-273
R130		22 k	2 w			306-223
R131		1 k	½ w			302-102
R132		47 Ω	½ w			302-470
R133	101-3000	3.3 k	1 w	Checked to 6 k, 2 w, 2½%.		*312-569
R134		2.7 k	1 w			
R133	3001-up	Deleted				
R134	3001-up	6 k	3 w	Mica Plate		*310-555
R136	101-3000X	56 k	1 w		5%	303-563
R137		47 Ω	½ w			302-470
R138		47 Ω	½ w			302-470
R141		39 k	1 w			
R143	101-3000	33 k	1 w	Checked to ratio of 5% ea. other		*312-570
R141	3001-up	33 k	1 w	Prec.	1%	310-070
R143	3001-up	30 k	1 w	Prec.	1%	310-072
R144		8 k	5 w	WW	5%	308-053
R146	101-3000	100 Ω	½ w			302-101
	3001-up	47 Ω	½ w			302-470
R147		1 k	½ w			302-102
R148	101-3000	39 k	½ w			302-393
	3001-up	47 k	½ w			302-473
R150		270 Ω	½ w			302-271
R152	101-300	36 k	½ w		5%	301-363
	301-up	68 k	½ w			302-683
R153		1 meg	½ w			302-105
R154		10 k	½ w			302-103
R155		1 meg	½ w			302-105
R156		1.8 meg	½ w			302-185
R157	X301-up	1 k	½ w			302-102
R158	101-300	220 k	½ w			302-224
	301-up	470 k	½ w			302-474
R159	101-300	1.2 k	½ w			302-122
	301-up	3.3 k	2 w			306-332
R160A		100 k	½ w	Prec.	1%	309-045

Resistors *(continued)*

							Tektronix Part Number
R160B		200 k	½ w		Prec.	1%	309-051
R160C		500 k	½ w		Prec.	1%	309-003
R160D		1 meg	½ w		Prec.	1%	309-014
R160E		2 meg	½ w		Prec.	1%	309-023
R160F		5 meg	½ w		Prec.	1%	309-087
R160G		10 meg	1 w		Prec.	1%	310-107
R160H		10 meg	1 w		Prec.	1%	310-107
R160J		30 meg	2 w		Prec.	1%	310-505
R160V	X1560-up	1 meg	½ w				302-105
R160X		10 k	½ w				302-103
R160Y	101-315	20 k	2 w	Var.		VARIABLE	311-083
	316-up	20 k	2 w	Var.	WW	VARIABLE	311-108
R160Z		100 k	½ w				302-104
R162		6.8 k	1 w				304-682
R163		12 k	1 w				304-123
R164		22 k	2 w				306-223
R165		22 k	2 w				306-223
R166		22 k	2 w				306-223
R167		1.5 meg	½ w				302-155
R168		47 k	½ w				302-473
R170		47 Ω	½ w				302-470
R172		47 Ω	½ w				302-470
R173		470 Ω	½ w				302-471
R174		8 k	5 w		WW	5%	308-053
R176		2 k	2 w	Var.		Swp. Length	311-008
R178		4 k	5 w		WW	5%	308-051
R180A		470 k	½ w				302-474
R180B		4.7 meg	½ w				302-475
R181		4.7 meg	½ w				302-475
R183		100 Ω	½ w				302-101
R191		100 k	½ w				302-104
R193		100 k	1 w				304-104
R195		47 k	½ w				302-473
R196	101-3000	100 k	½ w				302-104
	3001-up	110 k	½ w			5%	301-114
R197	101-3000	100 Ω	½ w				302-101
	3001-up	47 Ω	½ w				302-470
R198		47 Ω	½ w				302-470
R199		4.7 k	1 w				304-472
R301	X474-up	47 Ω	½ w				302-470
R310		900 k	½ w		Prec.	1%	309-111
R311		111 k	½ w		Prec.	1%	309-046
R313		990 k	½ w		Prec.	1%	309-013
R314		10.1 k	½ w		Prec.	1%	309-034
R320		1 meg	½ w		Prec.	1%	309-014
R321		1 k	½ w				302-102
R323	101-1219	47 k	1 w				304-473
	1220-up	33 k	2 w				306-333
R325		15 k	½ w	Var.		VARIABLE	311-112
R327	101-1219	47 k	1 w				304-473
	1220-up	33 k	2 w				306-333

							Tektronix Part Number
R328	101-1219	33 k	2 w				306-333
	1220-up	27 k	2 w				306-273
R330		100 Ω	½ w				302-101
R331		3.3 k	½ w				302-332
R332		220 k	½ w				302-224
R334		100 k	2 w	Var.		Ext. Horiz. Amp. DC Bal.	311-026
R337		2 meg	½ w		Prec.	1%	309-023
R338		2 meg	½ w		Prec.	1%	309-023
R339		330 Ω	½ w				302-331
R340 †		50 k	½ w	Var.		HORIZ. POS.	311-109
R342		2 meg	.1 w	Var.		X10 Cal.	311-082
R343		1.5 meg	½ w		Prec.	1%	309-017
R344		10 meg	½ w		Prec.	1%	309-095
R346 †		50 k	½ w	Var.		VERNIER	311-109
R347		47 k	½ w				302-473
R348		100 Ω	½ w				302-101
R349		47 k	1 w				304-473
R351		100 Ω	½ w				302-101
R353		30 k	1 w			5%	303-303
R354		6 k	½ w		Prec.	1%	309-099
R355	101-2159	136 Ω	½ w		Prec.	1%	Use 309-072
R355	2160-up	180 Ω	½ w		Prec.	1%	309-072
R356		500 Ω	1/10 w	Var.		X100 Cal.	311-056
R358		10 k	5 w		WW	5%	308-054
R359		5 k	2 w	Var.		Swp./Mag. Regis.	311-011
R360		12 k	8 w		WW	5%	308-093
R361A		5.6 k	½ w				302-562
R361B		11.76 k	½ w		Prec.	¼%	309-200
R361C		3.3 k	½ w				302-332
R361D		2.85 k	½ w		Prec.	¼%	309-201
R361E		1.2 k	½ w				302-122
R361F		1.2 k	½ w		Prec.	¼%	309-202
R361G		680 Ω	½ w				302-681
R361H		505.4 Ω	½ w		Prec.	¼%	309-203
R361J		390 Ω	½ w				302-391
R361K		122.5 Ω	½ w		Prec.	¼%	309-204
R361L		1 k	½ w				302-102
R361M		2.5 k	1/10 w	Var.		Ext. Horiz. Amp. Cal.	311-010
R361Y		100 k	½ w				302-104
R361Z		100 k	½ w				302-104
R363		330 k	½ w				302-334
R364		330 k	½ w				302-334
R365		500 Ω	1/10 w	Var.		DC Shift	311-056
R368		5 k	1/10 w	Var.		X1 Cal.	311-074
R369		31.1 k	½ w		Prec.	1%	309-037
R371		100 Ω	½ w				302-101

† R340 and R346 concentric. Furnished as a unit.

Resistors *(continued)*

							Tektronix Part Number
R372		30 k	1 w			5%	303-303
R373		6 k	½ w		Prec.	1%	309-099
R376		100 Ω	½ w				302-101
R377		100 Ω	½ w				302-101
R378		6—25 k	5 w		Mica Plate	1%	*310-506
R379		470 k	½ w				302-474
R380		820 k	½ w				302-824
R381		100 Ω	½ w				302-101
R382		6—25 k	5 w		Mica Plate	1%	*310-506
R384		12 k	8 w		WW	5%	308-093
R386		100 Ω	½ w				302-101
R387		41.5 k	5 w		Mica Plate	1%	*310-512
R388		41.5 k	5 w		Mica Plate	1%	*310-512
R389		820 k	½ w				302-824
R390		470 k	½ w				302-474
R391		10 k	½ w				302-103
R394		100 Ω	½ w				302-101
R395		2.2 k	½ w				302-222
R397		100 k	½ w				302-104
R398		150 k	½ w				302-154
R600	X3001-up	12 Ω	1 w				304-120
R601	X3001-up	30 Ω	3 w		WW	5%	308-142
R602	X3001-up	50 Ω	2 w	Var.	WW	SCALE ILLUM.	311-055
R604	X3001-up	6 k	5 w		WW	5%	308-052
R608	X3001-up	33 k	½ w				302-333
R610	X3001-up	100 k	½ w				302-104
R615	X3001-up	68 k	1 w		Prec.	1%	310-054
R616	X3001-up	10 k	2 w	Var.	WW	—150 V Adj.	311-015
R617	X3001-up	50 k	1 w		Prec.	1%	310-086
R618	X3001-up	100 k	½ w				302-104
R621	X3001-up	1 k	½ w				302-102
R623	X3001-up	470 k	½ w				302-474
R625	X3001-up	100 k	½ w				302-104
R628	X3001-up	2.7 meg	½ w				302-275
R629	X3001-up	2.7 meg	½ w				302-275
R633	X3001-up	1 meg	½ w				302-105
R635	X3001-up	15 k	1 w				304-153
R636	X3001-up	15 k	1 w				304-153
R637	X3001-up	150 k	½ w				302-154
R638	X3001-up	27 k	½ w				302-273
R639	X3001-up	68 k	½ w				302-683
R640	X3001-up	10 Ω	1 w				304-100
R641	X3001-up	10 Ω	1 w				304-100
R643	X3001-up	1 k	½ w				302-102
R644	X3001-up	1 k	½ w				302-102
R647	X3001-up	1 k	25 w		WW	5%	308-037
R648	X3001-up	10 Ω	½ w				302-100
R650	X3001-up	333 k	1 w		Prec.	1%	310-056

							Tektronix Part Number
R651	X3001-up	490 k	1 w		Prec.	1%	310-057
R663	X3001-up	1.5 meg	½ w				302-155
R667	X3001-up	680 k	½ w				302-684
R668	X3001-up	47 k	½ w				302-473
R669	X3001-up	39 k	½ w				302-393
R670	101-3000	150 k	½ w				302-154
	3001-up	10 Ω	2 w				306-100
R671	101-3000X	1 k	½ w				302-102
R672	101-300	3.3 meg	½ w				302-335
	301-3000X	3.9 meg	½ w				302-395
R673	101-3000X	2.7 meg	½ w				302-275
R674	101-3000X	1 k	½ w				302-102
R675	101-3000	68 k	½ w				302-683
	3001-up	750 Ω	10 w		WW	5%	308-016
R676	101-3000	33 k	1 w				304-333
	3001-up	3 k	10 w		WW	5%	308-020
R677	X3001-up	1.5 k	25 w		WW	5%	308-040
R679	101-3000X	10 k	2 w	Var.		Cal Adj.	311-016
R680	101-526	100 k	½ w				302-104
	527-3000	68 k	½ w				302-683
	3001-up	333 k	1 w		Prec.	1%	310-056
R681	101-3000	1.5 meg	½ w				302-155
	3001-up	220 k	1 w		Prec.	1%	310-055
R682	101-3000	100 Ω	½ w				302-101
	3001-up	120 k	½ w				302-124
R683	101-3000	9.5 k	½ w		Prec.	1%	309-121
	3001-up	1 k	½ w				302-102
R684	101-3000X	6.375 k	½ w		Prec.	1%	309-119
R685	101-3000	2.1 k	½ w		Prec.	1%	309-117
	3001-up	82 k	1 w				304-823
R686	101-3000	1.025 k	½ w		Prec.	1%	309-116
	3001-up	180 k	½ w				302-184
R687	101-3000X	610 Ω	½ w		Prec.	1%	309-113
R688	101-3000	200 Ω	½ w		Prec.	1%	309-073
	3001-up	1.5 meg	½ w				302-155
R689	101-3000	100 Ω	½ w		Prec.	1%	309-112
	3001-up	2.2 meg	½ w				302-225
R690	101-3000X	60 Ω	½ w		Prec.	1%	309-067
R691	101-3000X	40 Ω	½ w		Prec.	1%	309-066
R693	X3001-up	1.5 meg	½ w				302-155
R694	101-3000X	100 k	½ w		Prec.	1%	309-045
R695	101-3000X	100 Ω	½ w		Prec.	1%	309-112
R697	X3001-up	1 meg	½ w				302-105
R698	101-3000	.25 Ω	1 w	Special	WW		*308-090
	3001-up	270 k	½ w				302-274
R699	101-3000	100 Ω	½ w				302-101
	3001-up	56 k	½ w				302-563
R700	101-3000	15 k	1 w				304-153
	3001-up	10 Ω	2 w				306-100
R701	101-3000X	15 k	1 w				304-153
R703	101-3000X	68 k	½ w				302-683
R704	101-3000X	27 k	½ w				302-273

Resistors *(continued)*

							Tektronix Part Number
R706	101-3000X	2.7 meg	½ w				302-275
R707	101-3000X	2.7 meg	½ w				302-275
R708	101-3000X	12 Ω	1 w				304-120
R710	101-3000	33 k	½ w				302-333
	3001-up	237 k	1 w		Prec.	1%	310-124
R711	101-3000	100 k	½ w				302-104
	3001-up	100 k	½ w		Prec.	1%	309-334
R712	101-3000	100 k	½ w				302-104
	3001-up	150 k	½ w				302-154
R713	101-3000X	1 k	½ w				302-102
R715	101-3000X	50 k	1 w		Prec.	1%	310-086
R716	101-3000X	10 k	2 w	Var.	WW	—150 V Adj.	311-015
R717	101-3000X	100 k	½ w				302-104
R718	101-3000X	68 k	1 w		Prec.	1%	310-054
R719	101-3000X	470 k	½ w				302-474
R720	101-3000X	10 Ω	½ w				302-100
R723	X3001-up	1.5 meg	½ w				302-155
R724	101-3000X	1 k	25 w		WW	5%	308-037
R726	101-3000X	1 k	½ w				302-102
R727	101-3000	1 k	½ w				302-102
	3001-up	1 meg	½ w				302-105
R728	101-3000	150 k	½ w				302-154
	3001-up	560 k	½ w				302-564
R729	101-3000	1 meg	½ w				302-105
	3001-up	47 k	½ w				302-473
R730	X950-3000	22 Ω	2 w				306-220
	3001-up	10 Ω	1 w				304-100
R731	X950-3000	22 Ω	2 w				306-220
	3001-up	10 Ω	1 w				304-100
R732	101-3000	10 Ω	1 w				304-100
	3001-up	82 k	2 w				306-823
R733	101-3000X	10 Ω	1 w				304-100
R734	X3001-up	1 k	½ w				302-102
R735		100 k	½ w				302-104
R736	101-3000	50 Ω	2 w	Var.	WW	SCALE ILLUM.	311-055
	3001-up	2 k	25 w		WW	5%	308-065
R737	X3001-up	2 k	25 w		WW	5%	308-065
R740	101-3000	10 Ω	1 w				304-100
	3001-up	220 k	1 w		Prec.	1%	310-055
R741	X950-3000	7.5 Ω	10 w		WW	5%	308-125
	3001-up	720 k	1 w		Prec.	1%	310-059
R742	101-3000X	47 k	½ w				302-473
R743	101-3000X	39 k	½ w				302-393
R744	101-3000X	680 k	½ w				302-684
R747	101-3000X	1.5 meg	½ w				302-155
R748	101-3000X	3 k	10 w		WW	5%	308-020
R749	101-3000X	750 Ω	10 w		WW	5%	308-016
R750	101-3000X	333 k	1 w		Prec.	1%	310-056
R751	101-3000X	490 k	1 w		Prec.	1%	310-057
R752		2.2 Ω	½ w		WW	5%	308-116
R753	X950-3000	1 Ω	½ w		WW	5%	*308-141
R753	3001-up	1 meg	½ w				302-105

						Tektronix Part Number
R754	X950-3000X	10 Ω	2 w			306-100
R755	X950-3000X	10 Ω	2 w			306-100
R756	101-3000X	10 Ω	2 w			306-100
R757	101-3000	270 k	½ w			302-274
	3001-up	150 k	½ w			302-154
R758	101-3000	56 k	½ w			302-563
	3001-up	120 k	½ w			302-124
R759	X3001-up	27 k	½ w			302-273
R760	101-3000	1.5 meg	½ w			302-155
	3001-up	10 Ω	½ w			302-100
R762	101-300	2.5 k	10 w	WW	5%	308-018
	301-3000X	2 k	20 w	WW	5%	308-031
R763	101-3000X	1.5 meg	½ w			302-155
R764	101-3000X	2.2 meg	½ w			302-225
R765	101-3000X	180 k	½ w			302-184
R766	101-3000X	82 k	1 w			304-823
R767	101-3000	1 k	½ w			302-102
	3001-up	3 k	8 w	WW	5%	308-113
R770	101-3000X	2.2 meg	½ w			302-225
R771	101-3000X	220 k	1 w	Prec.	1%	310-055
R772	101-3000X	333 k	1 w	Prec.	1%	310-056
R775	X950-3000X	22 Ω	2 w			306-220
R776	X950-3000X	22 Ω	2 w			306-220
R777	101-3000X	10 Ω	1 w			304-100
R778	101-3000X	82 k	2 w			306-823
R779	101-3000X	2.2 meg	½ w			302-225
R780	101-3000X	10 Ω	1 w			304-100
R781	101-3000X	1 meg	½ w			302-105
R782	101-3000X	560 k	½ w			302-564
R783	101-3000X	47 k	½ w			302-473
R784	101-3000X	1.5 meg	½ w			302-155
R785	101-380	1.5 k	25 w	WW	5%	308-040
	381-3000X	2 k	25 w	WW	5%	308-065
R786	101-380	1.5 k	25 w	WW	5%	308-040
	381-3000X	2 k	25 w	WW	5%	308-065
R787	101-2099	236 k	1 w	WW	1%	308-083
	2100-3000X	237 k	1 w	Prec.	1%	310-124
R788	101-3000X	100 k	½ w	Prec.	1%	Use 309-334
R789	101-3000X	1 k	½ w			302-102
R790	101-3000X	10 Ω	½ w			302-100
R791	101-3000X	150 k	½ w			302-154
R792	101-3000X	120 k	½ w			302-124
R793	101-3000X	27 k	½ w			302-273
R794	101-3000X	1 meg	½ w			302-105
R795	101-3000X	3 k	8 w	WW	5%	308-113
R797	101-3000X	220 k	1 w	Prec.	1%	310-055
R798	101-3000X	720 k	1 w	Prec.	1%	310-059
R800		1 k	½ w			302-102
R803		56 k	2 w			306-563

Resistors *(continued)*

							Tektronix Part Number
R804		100 k	½ w				302-104
R805		1 k	½ w				302-102
R807		390 Ω	2 w				306-391
R810		470 k	½ w				302-474
R811		2 meg	2 w	Var.		H.V. Adj.	311-042
R812		2.2 meg	½ w				302-225
R813		4.7 meg	½ w				302-475
R814		4.7 meg	½ w				302-475
R815		4.7 meg	½ w				302-475
R825		1 meg	½ w				302-105
R827	X3001-up	1.8 meg	½ w				302-185
R828	X3001-up	1.8 meg	½ w				302-185
R829	X3001-up	33 k	½ w				302-333
R830		47 k	½ w				302-473
R831		1 meg	½ w	Var.		INTENSITY	311-041
R832		4.7 meg	½ w				306-475
R833		4.7 meg	2 w				306-475
R834	101-1429	100 k	½ w				302-104
	1430-up	33 k	½ w				302-333
R835		1 meg	½ w				302-105
R836	X3001-up	22 k	½ w				302-223
R838		100 Ω	½ w				302-101
R840		68 k	2 w				306-683
R841		47 Ω	½ w				302-470
R842		100 k	2 w	Var.		Geom. Adj.	311-026
R850		2.2 meg	2 w				306-225
R851		2.2 meg	2 w				306-225
R852		2 meg	½ w	Var.		FOCUS	311-043
R853		1 meg	2 w				306-105
R855		10 k	½ w				302-103
R856		27 k	½ w				302-273
R857		1 meg	½ w				302-105
R860		50 k	2 w	Var.		ASTIGMATISM	311-023
R863		100 k	½ w				302-104
R864		150 k	½ w				302-154
R870	X3001-up	150 k	½ w				302-154
R871	X3001-up	2.7 meg	½ w				302-275
R872	X3001-up	1 k	½ w				302-102
R874	X3001-up	3.9 meg	½ w				302-295
R875	X3001-up	68 k	½ w				302-683
R876	X3001-up	1 k	½ w				302-102
R878	X3001-up	33 k	1 w				304-333
R879	X3001-up	10 k	2 w	Var.		Cal. Adj.	311-016
R880	X3001-up	100 k	½ w				302-104
R883	X3001-up	100 Ω	½ w				302-101
R885	X3001-up	9.5 k	½ w		Prec.	1%	309-121
R886	X3001-up	6.375 k	½ w		Prec.	1%	309-119
R887	X3001-up	2.1 k	½ w		Prec.	1%	309-117
R888	X3001-up	1.025 k	½ w		Prec.	1%	309-116
R889	X3001-up	610 Ω	½ w		Prec.	1%	309-113
R890	X3001-up	200 Ω	½ w		Prec.	1%	309-073
R891	X3001-up	100 Ω	½ w		Prec.	1%	309-112

							Tektronix Part Number
R892	X3001-up	60 Ω	½ w		Prec.	1%	309-067
R893	X3001-up	40 Ω	½ w		Prec.	1%	309-066
R896	X3001-up	100 k	½ w		Prec.	1%	309-045
R897	X3001-up	100 Ω	½ w		Prec.	1%	309-112
R898	X3001-up	100 Ω	½ w				302-101
R899	X3001-up	.25 Ω	1 w		WW		*308-090
R1003		100 Ω	1 w				304-101
R1005		100 Ω	1 w				304-101
R1007		47 Ω	½ w				302-470
R1008		47 Ω	½ w				302-470
R1009		100 Ω	1 w				304-101
R1011		27 Ω	½ w				302-270
R1013		910 Ω	2 w			5%	305-911
R1014	101-659	500 Ω	½ w		Prec.	2%	*310-515
	660-up	500 Ω	½ w		Prec.	1%	309-179
R1016	101-181	4 k	5 w		WW	5%	308-051
	182-up	3 k	5 w		WW	5%	308-062
R1017	101-181	12 k	8 w		WW	5%	308-069
	182-up	10 k	8 w		WW	5%	308-126
R1018		330 Ω	½ w				302-331
R1019		470 k	½ w				302-474
R1021		27 Ω	½ w				302-270
R1023		150 k	½ w				302-154
R1024	101-659	500 Ω	½ w		Prec.	2%	*310-515
	660-up	500 Ω	½ w		Prec.	1%	309-179
R1026		330 Ω	½ w				302-331
R1027		200 Ω	2 w	Var.		Grain Adj.	Use 311-333
R1029		470 k	½ w				302-474
R1031	101-181	4.7 k	1 w				304-472
	182-up	2.2 k	1 w				304-222
R1033	101-318	1.5 k	5 w		WW	5%	308-061
	319-up	2.5 k	5 w		WW	5%	308-127
R1036		27 k	2 w				306-273
R1039	101-318	39 Ω	½ w				302-390
	319-up	33 Ω	½ w				302-330
R1046		27 k	2 w				306-273
R1049	101-318	39 Ω	½ w				302-390
	319-up	33 Ω	½ w				302-330
R1052		470 k	½ w				302-474
R1054		167 Ω	5 w		WW	5%	308-104
R1055		4.5 k	5 w		WW	5%	308-066
R1062		470 k	½ w				302-474
R1064	101-599X	2 k	1 w			5%	303-202
R1071		600 Ω	5 w	Paired to within ½% ea. other			*312-587
R1073		600 Ω	5 w				
R1075		220 Ω	¼ w				316-221
R1077		47 Ω	¼ w				316-470
R1078		150 Ω	¼ w				316-151
R1080	101-3000	150 k	½ w				302-154
R1080	3001-up	100 k	½ w				302-104
R1081		330 k	½ w				302-334

Resistors *(continued)*

							Tektronix Part Number
R1083	101-3000	390 k	½ w				302-394
R1083	3001-up	330 K	½ w				302-334
R1084		180 k	½ w				302-184
R1085		1 meg	¼ w				316-105
R1087	101-3000	390 k	½ w				302-394
R1087	3001-up	330 K	½ w				302-334
R1089		1 meg	¼ w				316-105
R1090	101-3089	8.2 k	¼ w			Selected Usually	316-822
R1090*	3090-up	6.8 k	¼ w			10%	316-682
R1091		250 k	2 w	Var.		DC Shift	311-061
R1092		47 k	½ w				302-473
R1093	X3200-up	56 k	1 w	Fixed	Comp.	10%	304-563
R1094		68 k	.1 w				307-006
R1095	101-3089	8.2 k	¼ w			Selected Usually	316-822
R1095	3090-up	6.8 k	¼ w			10%	316-682
R1097		47 k	½ w				302-473
R1099		68 k	.1 w				307-006
R1102		470 k	½ w				302-474
R1105		4.5 k	5 w		WW	5%	308-066
R1112		470 k	½ w				302-474
R1122		470 k	½ w				302-474
R1125		4.5 k	5 w		WW	5%	308-066
R1132		470 k	½ w				302-474
R1142		470 k	½ w				302-474
R1145		4.5 k	5 w		WW	5%	308-066
R1152		470 k	½ w				302-474
R1162		470 k	½ w				302-474
R1165		4.5 k	5 w		WW	5%	308-066
R1172		470 k	½ w				302-474
R1182		470 k	½ w				302-474
R1185		4.5 k	5 w		WW	5%	308-066
R1192		470 k	½ w				302-474
R1202		470 k	½ w				302-474
R1205		4.5 k	5 w		WW	5%	308-066
R1206		360 Ω	½ w			5%	301-361
R1208		12 k	8 w		WW	5%	308-069
R1212		470 k	½ w				302-474
R1216		360 Ω	½ w			5%	301-361
R1218		1 k	5 w			5%	308-106
R1221		100 Ω	½ w				302-101
R1223	101-318	2.7 k	2 w				306-272
	319-up	4.7 k	2 w				306-472
R1224		30 k	10 w		WW	5%	308-027
R1226		100 Ω	½ w				302-101
R1227		15 k	2 w				306-153
R1228		1 meg	½ w				302-105
R1301-1308		1 k	½ w				(8) 302-102

Switches

				Unwired	Wired
SW10A	101-300	Rotary	TRIGGER SLOPE	*260-099	*262-150
SW10B	101-300	Rotary	TRIGGERING MODE		
SW10A	301-up	Rotary	TRIGGER SLOPE	*260-099 Use	*262-561
SW10B	301-up	Rotary	TRIGGERING MODE		

* Value may change if 8136/6DK6 tubes of different manufacture are substituted.

Switches *(continued)*

				Tektronix Part Number	
				Unwired	Wired
SW110 †			Preset	311-096	
SW120			SINGLE SWEEP RESET	260-190	
SW160††	101-315	Rotary	TIME/CM	*260-203	*262-147
	316-3000	Rotary	TIME/CM	*260-230	*262-147
	3001-up	Rotary	TIME/CM	*260-230	*262-244
SW160Y				311-108	
SW310		Rotary	HORIZ. VOLTS/CM	*260-207	*262-152
SW360	101-3000	Rotary	HORIZ. DISPLAY	*260-210	*262-151
	3001-up	Rotary	HORIZ. DISPLAY	*260-210	*262-412
SW601	X3001-up	Toggle	POWER ON	260-134	
SW670	101-3000X	Rotary	VOLTS MILLIVOLTS OFF	*260-177	*262-132
SW680	101-3000X	Rotary	SQUARE WAVE CALIBRATOR		
SW701	101-3000X	Toggle	Power ON	260-134	
SW800		Toggle	CRT CATHODE SELECTOR	260-209	
SW870	X3001-up	Rotary	AMPLITUDE CALIBRATOR	*260-253	*262-207

Thermal Cutout

TK601	X3001-up	Thermal Cutout 133°		260-208
TK701	101-3000X	Thermal Cutout 128°F ±5° Off.		260-070
		113°F ±5° On.		

Transformers

T601	X3001-up	Plate & Heater	Domestic & Export voltage range	use *120-140
T700	101-3000X	Plate & Heater	117 V	*120-037
		Plate & Heater	234 V	*120-086
T801		CRT Supply		*120-036

Electron Tubes

V24	101-300	6BQ7A	154-028
	301-up	6DJ8	154-187
V45	101-300	6U8	154-033
	301-up	6DJ8	154-187
V125		6AU6	154-022
V133	101-300	6BQ7A	154-028
	301-up	6DJ8	154-187
V135	101-300	6BQ7A	154-028
	301-up	6DJ8	154-187
V146		12BY7	154-047
V152		6AL5	154-016
V154	101-300	6U8	154-033
	301-up	6DJ8	154-187
V161		12AU6	154-040

†SW110 concentric with R17 and ganged with R110. Furnished as a unit.

††SW160 concentric with SW160Y and R160Y.

Electron Tubes *(continued)*

			Tektronix Part Number
V173	101-300	6BQ7A	154-028
	301-up	6DJ8	154-187
V183	101-300	6BQ7A	154-028
	301-up	6DJ8	154-187
V193	101-300	6BQ7A	154-028
	301-up	6DJ8	154-187
V246	101-300	6BQ7A	154-028
	301-3000X	12AU7	154-041
V324	101-300	6BQ7A	154-028
	301-up	6DJ8	154-187
V343		12AU6	154-040
V354		6EW6/6DK6	Use 154-212
V364		6EW6/6DK6	Use 154-212
V374		6BA8	154-163
V384		6BA8	154-163
V394		8136	Use 154-367
V609	X3001-up	5651	154-052
V624	X3001-up	12AX7	154-043
V627	X3001-up	12B4	154-044
V634	X3001-up	6AU6	154-022
V637	X3001-up	12B4	154-044
V647	X3001-up	12B4	154-044
V664	X3001-up	6AU6	154-022
V670	101-300	6U8	154-033
	301-3000X	6AU6	154-022
V677	X3001-up	6080	154-056
V684	X3001-up	12AX7	154-043
V694	X3001-up	6AU6	154-022
V700	101-3000X	6AU6	154-022
V710	101-3000X	5651	154-052
V712	101-3000X	12AX7	154-043
V724	X3001-up	6AU6	154-022
V725	101-3000X	12B4	154-044
V726	101-3000X	12B4	154-044
V727	101-3000X	12B4	154-044
V737	X3001-up	6080	154-056
V742	101-3000X	6AU6	154-022
V748	101-3000X	6080	154-056
V754	X3001-up	6AU6	154-022
V757	101-3000X	6AU6	154-022
V765	101-3000X	12AX7	154-043
V767	X3001-up	12B4	154-044
V782	3000-up	6AU6	154-022
V784	101-3000X	6080	154-056
V791	101-3000X	6AU6	154-022

				Tektronix Part Number
V794	101-3000X	12B4		154-044
V800		6AU5GT		154-021
V814		12AU7		154-041
V822 †	X1560-up	5642		154-051
V832 †	X1560-up	5642		154-051
V842 †	X1560-up	5642		154-051
V852 †	X1560-up	5642		154-051
V862 †	X1560-up	5642		154-051
V859		T5430-2	CRT Standard Phosphor	*154-175
V875	X3001-up	6AU6		154-022
V885	X3001-up	12AU7		154-041
V1014 ‡		12BY7A	Selected	*157-053
V1024 ‡		12BY7A	Selected	*157-053
V1033	101-318	6BQ7A		154-028
	319-up	6DJ8		154-187
V1043	101-318	6BQ7A		154-028
	319-up	6DJ8		154-187
V1054		8136		Use 154-367
V1064		8136		Use 154-367
V1084		12AU7		154-041
V1104		8136		Use 154-367
V1114		8136		Use 154-367
V1124		8136		Use 154-367
V1134		8136		Use 154-367
V1144		8136		Use 154-367
V1154		8136		Use 154-367
V1164		8136		Use 154-367
V1174		8136		Use 154-367
V1184		8136		Use 154-367
V1194		8136		Use 154-367
V1204		8136		Use 154-367
V1214		8136		Use 154-367
V1223	101-318	6BQ7A		154-028
	319-up	6DJ8		154-187

† S/N 101-1559, V822 was V824, V832 was V821, V842 was V822, V852 was V823 and V862 was V820.
‡ V1014 & V1024 furnished as a unit.

Mechanical Parts List
Type 543/543A

	Tektronix Part Number
AIR FILTER	378-011
AIR FILTER	380-008
BAR, EXTRUDED, TOP SUPPORT, w/handles	Use 381-204
BAR, ALUM. 1/4 x 1/4 x 11 17/32 SN 101-4289	381-107
BAR, ALUM. TRANSFORMER SUPPORT SN 4290-up	381-212
BINDING POST ADAPTER	013-004
BINDING POST ASSEMBLY, 5 w, black	129-030
BINDING POST CAP BPN13	200-072
BINDING POST STEM BRN13	355-503
BRACKET, —150 ADJUST.	406-108
BRACKET, RECTIFIER MOUNTING SN 101-949	406-118
BRACKET, RELAY MTG. 1 1/4 x 2 3/4 x 3 1/8 SN 101-3000	406-144
BRACKET, COIL MTG. MOLDED PLASTIC 3/16 x 1 1/2	406-175
BRACKET, COAX INSULATOR, MOLDED NYLON	406-244
BRACKET, PHOSPHOR BRONZE, ground clip	406-245
BRACKET, SWITCH 1 x 2 5/16	406-316
BRACKET, 7 POT	406-348
BRACKET, SWITCH 1 x 2 1/4 x 1/2	406-349
BRACKET, MINIPOT 1 3/4 x 1 5/8 x 3/8	406-351
BRACKET, ALUM. V.A. SUPPORT SN 4290-up	406-827
BUSHING, ALUM. 3/8 - 32 x 9/16 x .412	358-010
BUSHING, HEX 3/8 - 32 x 13/32 x .252 ID	358-029
BUSHING, NYLON for 5-way binding post	358-036
BUSHING, MINIATURE POT	358-051
BUSHING, POT MTG. .343 OD x 1/4-32 x .295	358-074
CABINET BOTTOM SN 101-1589	386-597
CABINET BOTTOM SN 1590-4289	387-061
CABINET BOTTOM SN 4290-up	387-478
CABINET SIDE, LEFT SN 101-1589	386-736
CABINET SIDE, LEFT SN 1590-up	387-077
CABINET SIDE, RIGHT SN 101-1589	386-770
CABINET SIDE, RIGHT SN 1590-up	387-076
CABLE HARNESS, F & I	179-061
CABLE HARNESS, V. A.	179-179
CABLE HARNESS, SWEEP SN 101-300	179-213
CABLE HARNESS, SWEEP SN 301-up	179-249
CABLE HARNESS, POWER SN101-3000	179-221

	Tektronix Part Number
CABLE HARNESS, POWER SN 3001-up	179-297
CABLE HARNESS, RECTIFIER SN 101-3000	179-222
CABLE HARNESS, SILICON RECTIFIER SN 3001-up	179-350
CABLE HARNESS, 110V SN101-3000	179-223
CABLE HARNESS, 110V SN 3001-up	179-306
CABLE HARNESS POWER #2 X3001-up	179-324
CABLE HARNESS 110V RECTIFIER X3001-up	179-305
CERAMIC STRIP 3/4" x 4 notches clip mounted	124-088
CERAMIC STRIP 3/4" x 7 notches clip mounted	124-089
CERAMIC STRIP 3/4" x 11 notches clip mounted	124-091
CERAMIC STRIP 3/4" x 2 notches clip mounted	124-086
CERAMIC STRIP 3/4" x 3 notches clip mounted	124-087
CERAMIC STRIP 3/4" x 9 notches clip mounted	124-090
CERAMIC CONNECTING POST 1"	129-017
CERAMIC CONNECTING POST 3/4"	129-034
CERAMIC CONNECTING POST 1/2"	129-009
CHASSIS, DELAY LINE	441-100
CHASSIS, DELAY LINE HORIZ.	441-114
CHASSIS, DELAY LINE VERT.	441-115
CHASSIS, DELAY LINE VERT. (New Cab. design)	441-137
CHASSIS, SWEEP	441-189
CHASSIS, F & I	441-223
CHASSIS, V. A.	441-205
CHASSIS, POWER SN 301-3000	441-212
CHASSIS, POWER SN 3001-up	441-238
CLAMP, CABLE 1/8" plastic	343-001
CLAMP, CABLE 3/16" plastic	343-002
CLAMP, CABLE 1/2" plastic	343-006
CLAMP, STEEL 2 7/32 ID w/2 mtg. feet	343-034
CLAMP, STEEL 1/2 x 3/4	343-036
CONNECTOR, 16-contact female	131-018
CONNECTOR, COAX, CHASSIS MT. SN 101-3000	131-038
CONNECTOR, CHASSIS MT. SN 3001-4489	131-081
CONNECTOR, CHASSIS MT. BNC SN 4490-up	131-126
CONNECTOR, COAX, CAL-OUT SN 3001-4489	131-064
CONNECTOR, CHASSIS MT. BNC SN 4490-up	131-279
CONNECTOR, 3-WIRE, molded motor base, chassis mt. S/N 330-up	131-102
COUPLING 1" long	376-007
COUPLING, POT, wire	376-014
CORD POWER-GREY VINYL SN 1105-up	161-017
CRT PIN CONNECTOR	131-049
CRT ANODE LEAD ASSEMBLY 31"	131-086
CRT CONTACT PLUG	134-031

Mechanical Parts List *(continued)*

	Tektronix Part Number
CRT ANODE COVER	200-111
CRT SHIELD	337-088
CRT ROTATING RING w/handle	354-066
COVER GRATICULE	200-382
CRT ANODE PLATE $2\frac{3}{8}$" x $2\frac{1}{2}$" w/$1\frac{1}{2}$" hole	386-647
CRT PHOSPHOR BRONZE SPRING BRACKET	406-239
CRT SUPPORT BRACKET	406-251
CRT ROTATOR BASE $2\frac{3}{4} \times 3\frac{3}{16} \times \frac{9}{16}$ SN1250-up	432-022
CRT ROTATOR SECURING RING, Nylon SN1250-up	354-178
CRT ROTATOR CLAMPING RING, Nylon SN1250-up	354-079
EYELET, TAPERED BARREL (5 & 10 watt resistors)	210-601
FAN BLADE 7"	369-007
FAN MOTOR	147-001
FAN MOTOR MOUNT	426-047
FAN RING $7\frac{3}{8}$	354-053
FELT STRIP (CRT) $\frac{1}{8} \times 1 \times 5\frac{3}{4}$	124-068
FRAME ANGLE $20\frac{7}{16}$ TOP LEFT	122-019
FRAME ANGLE $20\frac{7}{16}$ BOTTOM RIGHT	122-050
FRAME ANGLE $20\frac{7}{16}$ BOTTOM LEFT	122-051
FUSE CAP	200-015
FUSE HOLDER	352-010
GRATICULE LAMP SOCKET	136-001
GRATICULE COVER	200-025
GRATICULE LIGHT SHIELD	337-187
GRATICULE 5"	331-034
GRATICULE LIGHT FILTER, GREEN	378-514
GRATICULE CAM	401-004
GROMMET, RUBBER $\frac{1}{4}$"	348-002
GROMMET, RUBBER $\frac{5}{16}$"	348-003
GROMMET, RUBBER $\frac{3}{8}$"	348-004
GROMMET, RUBBER $\frac{1}{2}$"	348-005
GROMMET, RUBBER $\frac{3}{4}$"	348-006
GROMMET, RUBBER $\frac{1}{2}$" (round)	348-008
GROMMET, RUBBER $\frac{5}{8}$"	348-012
HOLDER, NEON BULB, double	352-006
HOLDER, NEON BULB, single	352-008
HOLDER, COIL, FORM, nylon	352-011
HOLDER, COIL FORM, nylon	352-015
JACK TIP SOCKET	136-037
JEWEL LIGHT SOCKET	136-025

	Tektronix Part Number
JEWEL, PILOT LIGHT	378-518
KNOB, SMALL RED 3/16 hole part way SN 1250-up	366-032
KNOB, SMALL BLACK 1/4 hole part way	366-033
KNOB, SMALL RED 1/8 hole part way	366-038
KNOB, SMALL RED 3/16 hole part way	366-039
KNOB, LARGE BLACK 1/4 hole thru 1.375 OD	366-040
KNOB, LARGE BLACK 1/4 hole part way	366-042
KNOB, LARGE BLACK 17/64 hole thru	366-046
KNOB, LARGE BLACK 1/4 hole thru 1.625 OD	366-058
LOCKWASHER #2 EXT	210-002
LOCKWASHER #4 INT	210-004
LOCKWASHER #6 INT	210-006
LOCKWASHER #8 EXT	210-007
LOCKWASHER #8 INT	210-008
LOCKWASHER #10 EXT	210-009
LOCKWASHER #10 INT	210-010
LOCKWASHER POT INT 3/8 x 1/2	210-012
LOCKWASHER POT INT 3/8 x 11/16	210-013
LOCKWASHER #5 spring	210-017
LOCKWASHER 5/16	210-018
LOCKWASHER INT 1/4	210-046
LUG, SOLDER SE4	210-201
LUG, SOLDER SE 6 w/2 holes	210-202
LUG, SOLDER DE 6	210-204
LUG, SOLDER SE 8	210-205
LUG, SOLDER SE 10, long	210-206
LUG, SOLDER 3/8	210-207
LUG, SOLDER 1/4 SN 1840-up	210-223
LUG, SOLDER #10 7/8 non-locking	210-224
NUT, HEX 2-56 x 3/16	210-405
NUT, HEX 4-40 x 3/16	210-406
NUT, HEX 6-32 x 1/4	210-407
NUT, HEX 8-32 x 5/16	210-409
NUT, HEX 10-32 x 3/8	210-445
NUT, HEX 3/8-32 x 1/2	210-413
NUT, HEX 15/32-32 x 9/16	210-414
NUT, HEX 10-24 x 3/8	210-416
NUT, HEX 3/8-32 x 1/2 x 7/16	210-421
NUT, GRATICULE, KNURLED	210-424
NUT, HEX 1-72 x 5/32	210-438

Mechanical Parts List *(continued)*

	Tektronix Part Number
NUT, HEX POT, 1/2" x 5/8" x 3/8-32 Internal Thread	210-444
NUT, HEX 5-40 x 1/4	210-449
NUT, KEP 6-32 x 5/16	210-457
NUT, KEP 8-32 x 11/32	210-458
NUT, HEX 8-32 x 1/2 x 23/64 25W resistor mtg.	210-462
NUT, POT 1/4-32 x 5/16 x 19/32	210-471
NUT, SWITCH 15/32-32 x 5/64 12-sided	210-473
NUT, (CRT ROTATOR) 3/8-32 x 10-32 SN1250-up	210-502
NUT (CRT ROTATOR) 21/32 x 2 1/2 SN1250-up	210-503
OVERLAY, REAR	386-767
PANEL, FRONT	333-446
PATCH CORD 18" red	012-031
PLATE, BAKELITE 3/32 x 2 3/4 x 5 1/4	386-358
PLATE, RECTIFIER MTG. .063 x 1 3/4 x 1 1/2 SN 950-up	386-361
PLATE .040 x 9/16 x 1 17/32	386-374
PLATE, PLEXIGLASS, DELAY LINE 1 15/16 x 12 1/4	386-437
PLATE, PLEXIGLASS, DELAY LINE 2 1/4 x 8 1/8	386-438
PLATE, RECTIFIER MTG. 11 5/8 x 11 1/2	386-764
PLATE, POT MTG. 3/4 x 7/8	386-768
PLUG-IN HOUSING TOP 5 15/16 x 8 3/4 x 2 1/8	337-066
PLUG-IN HOUSING SHIELD 7 7/8 x 6 13/32	337-091
PLUG-IN HOUSING BACK	386-355
PLUG-IN HOUSING SIDE 9 1/8 x 6 7/16	Use 386-680
POWER CORD ADAPTER 3-wire to 2-wire	103-013
POWER CORD	161-010
ROD, EXTENSION 1/8 x 3	384-100
ROD, SPACING 1/4 x 3 1/8	384-135
ROD, EXTENSION 1/8 x 8 7/16	384-162
ROD, EXTENSION 1/4 x 10 29/32	384-165
ROD, MTG. CAP, nylon, 5/16 x 1	384-542
ROD, NYLON 5/16 x 3/4	385-073
ROD, NYLON 5/16 x 1	385-074
ROD, NYLON 5/16 x 1 5/8	385-076
ROD, ALUM. 1/4 x 7/16	385-080
ROD, NYLON 5/16 x 2 1/4	385-082
ROD, NYLON 5/16 x 1 9/16	385-090

	Tektronix Part Number
ROD, NYLON 1/4 x 1 1/4	385-096
ROD, ALUM. 1/4 x 3 5/16	385-106
SCREW 4-40 x 3/16 BHS	211-007
SCREW 4-40 x 1/4 BHS	211-008
SCREW 4-40 x 5/16 BHS	211-011
SCREW 4-40 x 5/8 RHS	211-016
SCREW 4-40 x 1/4 FHS	211-023
SCREW 4-40 x 3/8 FHS	211-025
SCREW 4-40 x 1 FHS	211-031
SCREW 4-40 x 5/16 Pan HS w/lockwasher	211-033
SCREW 4-40 x 1/2 BHS Nylon	211-036
SCREW 6-32 x 3/16 BHS	211-503
SCREW 6-32 x 1/4 BHS	211-504
SCREW 6-32 x 1/4 FHS	211-506
SCREW 6-32 x 5/16 BHS	211-507
SCREW 6-32 x 5/16 FHS	211-508
SCREW 6-32 x 3/8 FHS	211-509
SCREW 6-32 x 3/8 BHS	211-510
SCREW 6-32 x 1/2 BHS	211-511
SCREW 6-32 x 3/4 BHS	211-514
SCREW 6-32 x 5/8 FHS	211-522
SCREW 6-32 x 1 3/4 BHS	211-530
SCREW 6-32 x 5/16 PAN HS w/lockwasher	211-534
SCREW 6-32 x 1 RHS SN 1250-up	211-560
SCREW 6-32 x 3/8 FHS SN 1250-up	211-561
SCREW 6-32 x 3/8 Truss HS Phillips	211-537
SCREW 6-32 x 5/16 Truss HS Phillips	211-542
SCREW 6-32 x 5/16 RHS	211-543
SCREW 8-32 x 5/16 BHS	212-004
SCREW 8-32 x 1/2 BHS	212-008
SCREW 8-32 x 1 1/4 FHS	212-012
SCREW 8-32 x 2 1/4 RHS	212-014
SCREW 8-32 x 3/8 BHS	212-023
SCREW 8-32 x 1 1/4 RHS	212-031
SCREW 8-32 x 1 3/4 RHS	212-032
SCREW 8-32 x 1 3/4 FHS	212-037

Mechanical Parts List *(continued)*

	Tektronix Part Number
SCREW 8-32 x 3/8 Truss HS Phillips	212-039
SCREW 8-32 x 3/8 FHS 100°	212-040
SCREW 8-32 x 1/2 RHS Phillips	212-044
SCREW 10-32 x 3 RHS	212-511
SCREW 10-24 x 7/8 RHS	212-536
SCREW, THREAD CUTTING 4-40 x 3/8 FHS	213-012
SCREW, THREAD CUTTING 4-40 x 5/16 RHS Phillips	213-034
SCREW, THREAD CUTTING 4-40 x 1/4 PHS Phillips	213-035
SCREW, THREAD CUTTING 6-32 x 3/8 Truss HS Phillips	213-041
SHIELD, SOCKET 13/16 ID SN 101-4329X	337-004
SHIELD, TUBE 7/8 ID w/spring 1 3/4 hi.	337-007
SHIELD, CAL. SWITCH	337-093
SHIELD, F & I	337-148
SHIELD, HV	337-150
SHIELD, HORIZ. AMP.	337-215
SHIELD, HORIZ. AMP.	337-219
SHIELD, HV SN1560-up	337-287
SOCKET, STM7G	136-008
SOCKET 7-pin EZ mate w/shield SN X4330-up	136-010
SOCKET, STM8	136-011
SOCKET, STM9G	136-015
SOCKET, STM14 14-pin	136-019
SOCKET, 7-pin w/1 1/8 dia, mtg. hole	136-044
SPACER .180 ID x 1/4 OD x 5/8	166-037
SPACER .180 ID x 1/4 OD x 3/4	166-038
SPACER .245 ID x 3/8 OD x 2 19/32	166-105
SPACER .180 ID x 1/4 OD x 7/32 one end c/sunk	166-107
SPACER, HV INSULATOR	361-001
SPACER, 5/32" nylon for Ceramic Strip	361-007
SPACER, 3/8" nylon for Ceramic Strip	361-009
SPACER RING .384 ID x 1/2 OD x 7/32	354-060
STUD, STEEL for CRT Rotator SN 1250-up	355-049
STUD, STEEL 10-32 x 2 7/16 2" under shoulder	355-044
SUBPANEL, FRONT	386-765
SUBPANEL, REAR	386-766
TAG, VOLTAGE RATING 117 V 105-125 V, 50-60 Cycles	334-649
TRANSFORMER STRAP, HV MOUNTING	346-001

	Tektronix Part Number
TUBING #2 black plastic	162-004
TUBING #5 black plastic	162-011
TUBING #7 clear plastic	162-012
TUBING #7 black plastic	162-013
TUBING #12 black plastic	162-014
TUBING #13 black plastic	162-015
TUBING #2 clear plastic	162-019
TUBING #18 black plastic	162-503
TUBING #20 black plastic	162-504
TUBING #20 white plastic	162-528
WASHER, STEEL 6L x 3/8 x .032	210-803
WASHER, STEEL 8S x 3/8 x .032	210-804
WASHER, STEEL 10S x 7/16 x .036 SN 950-up	210-805
WASHER, CENTERING 20 w	210-808
WASHER, FIBER #10	210-812
WASHER, RUBBER	210-816
WASHER, STEEL .390 ID x 9/16 OD x .020	210-840
WASHER, STEEL #2 .093 ID x 9/32 OD x .020	210-850
WASHER, STEEL #4L .119 ID x 3/8	210-851
WASHER, RUBBER 1/2 ID x 11/16 OD x 3/64	210-873
WIRE #20 SOLID white	175-510
WIRE #20 HV STRANDED white	175-513
WIRE #22 SOLID blue	175-520
WIRE #22 SOLID white	175-522
WIRE #22 STRANDED white	175-527
WIRE #26 STRANDED white	175-529
WIRE #22 SOLID natural	175-549
WIRE #14 TINNED COPPER	176-003

APPENDIX I

REFERENCES

Following is a list of references that are available to the operator and organizational, DS, GS, and depot maintenance repairmen of the oscilloscope.

DA Pam 310-4	Index of Technical Manuals, Technical Bulletins, Supply Manuals (types 7, 8, and 9), Supply Bulletins, Lubrication Orders, and Modification Work Orders.
TB SIG 364	Field Instructions for Painting and Preserving Electronics Command Equipment.
TM 38-750	Army Equipment Record Procedures.

APPENDIX II

BASIC ISSUE ITEMS LIST

Section I. INTRODUCTION

A2-1. General

This appendix lists items supplied for initial operation and for running spares. The list includes tools, parts, and material issued as part of the major end item. The list includes all items authorized for basic operator maintenance of the equipment. End items of equipment are issued on the basis of allowances prescribed in equipment authorization tables and other documents that are a basis for requisitioning.

A2-2. Columns

Columns are as follows:

a. Federal Stock Number. This column lists the 11-digit Federal stock number.

b. Designation by Model. Not used.

c. Description. Nomenclature or the standard item name and brief identifying data for each item are listed in this column. When requisitioning, enter the nomenclature and description.

d. Unit of Issue. The unit of issue is each unless otherwise indicated and is the supply term by which the individual item is counted for procurement, storage, requisitioning, allowances, and issue purposes.

e. Expendability. Nonexpendable items are indicated by NX. Expendable items are not annotated.

f. Quantity Authorized. Under "Items Comprising an Operable Equipment", the column lists the quantity of items supplied for the initial operation of the equipment. Under "Running Spare Items" the quantities listed are those issued initially with the equipment as spare parts. The quantities are authorized to be kept on hand by the operator for maintenance of the equipment.

g. Illustration. Not used.

Section II. OPERATOR'S FUNCTIONAL PARTS LIST

FEDERAL STOCK NUMBER	DESIGNATION BY MODEL	DESCRIPTION	UNIT OF ISSUE	EXP	QTY AUTH	ILLUSTRATION	
						FIGURE NO.	ITEM NO.
6625-808-8388		OSCILLOSCOPE: Tektronix Model 543 A Laboratory type instrument well suited to oscilloscope applications involving fast-rise pulses and transients. Plug-in preamplifiers are used in the vertical, deflection system, permitting the instrument to be used in many specialized applications Textronix Inc. Part No. 543.			1		
		ITEM COMPRISING AN OPERABLE EQUIPMENT					
Ord thru AGC		TECHNICAL MANUAL TM 11-6625-611-15			2		
		RUNNING SPARES					
5960-188-3544		ELECTRON TUBE: MIL type No. 6AL5			1		
5960-262-0151		ELECTRON TUBE: MIL type No. 6AU5			1		
5960-617-4920		ELECTRON TUBE: MIL type 6AU6			2		
5960-844-3684		ELECTRON TUBE: MIL type No. 6BA8A			1		
5960-262-3781		ELECTRON TUBE: MIL type 6BQ7A			2		
5960-800-0549		ELECTRON TUBE: MIL type No. 6DK6			2		
5960-262-0243		ELECTRON TUBE: MIL type 6U8			1		
5960-553-4578		ELECTRON TUBE: MIL type No. 12AU6			1		
5960-166-7663		ELECTRON TUBE: MIL type No. 12 AU7			1		
5960-166-7664		ELECTRON TUBE: MIL type No. 12AX7			1		
5960-636-0106		ELECTRON TUBE: MIL type No. 12B4			1		
5960-578-1602		ELECTRON TUBE: MIL type No. 12BY7			1		
5960-538-2363		ELECTRON TUBE: MIL type No. 12BY7A			1		
5960-230-5231		ELECTRON TUBE: MIL type No. 5642			1		
5960-707-6808		ELECTRON TUBE: MIL type No. 5651			1		
5960-543-1001		ELECTRON TUBE: MIL type No. 6080			1		

FEDERAL STOCK NUMBER	DESIGNATION BY MODEL	DESCRIPTION	UNIT OF ISSUE	EXP	QTY AUTH	ILLUSTRATION	
						FIGURE NO.	ITEM NO.
		OSCILLOSCOPE TEXTRONIX MODE 543 (continued)					
5960-810-4389		ELECTRON TUBE: Textronix Inc. Part No. 154-175			1		
5920-538-3494		FUSE: 3 amp .234v, 50 cys Bussman Part No. MDX3			5		
5920-199-9482		FUSE: 6 amp. 117v, 60 cys Bussman Part No. MTH6			1		

APPENDIX III

MAINTENANCE ALLOCATION

Section I. INTRODUCTION

A3-1. General

a. This appendix assigns maintenance functions to be performed on components, assemblies, and subassemblies by the lowest appropriate maintenance category.

b. Columns in the maintenance allocation chart are as follows:

(1) Part or component. This column shows only the nomenclature or standard item name. Additional descriptive data are included only where clarification is necessary to identify the component. Components, assemblies, and subassemblies are listed in top-down order. That is, the assemblies which are part of a component are listed immediately below that component, and subassemblies which are part of an assembly are listed immediately below that assembly. Each generation breakdown (components, assemblies, or subassemblies) are listed in disassembly order or alphabetical order.

(2) Maintenance function. This column indicates the various maintenance functions allocated to the categories.

(a) Service. To clean, to preserve, and to replenish lubricants.

(b) Adjust. To regulate periodically to prevent malfunction.

(c) Inspect. To verify serviceability and detect incipient electrical or mechanical failure by scrutiny.

(d) Test. To verify serviceability and to detect incipient electrical or mechanical failure by use of special equipment such as gages, meters, etc.

(e) Replace. To substitute serviceable components, assemblies, or subassemblies, for unserviceable components, assemblies, or subassemblies.

(f) Repair. To restore an item to serviceable condition through correction of a specific failure or unserviceable condition. This function includes but is not limited to welding, grinding, riveting, straightening, and replacement of parts other than the trial and error replacement of running spare type items such as fuses, lamps, or electron tubes.

(g) Align. To adjust two or more components of an electrical system so that their functions are properly synchronized.

(h) Calibrate. To determine, check, or rectify the graduation of an instrument, weapon, or weapons system, or components of a weapons system.

(i) Overhaul. To restore an item to completely serviceable condition as prescribed by serviceability standards developed and published by heads of technical services. This is accomplished through employment of the technique of "Inspect and Repair Only as Necessary" (IROAN). Maximum utilization of diagnostic and test equipment is combined with minimum disassembly of the item during the overhaul process.

(j) Rebuild. To restore an item to a standard as near as possible to original or new condition in appearance, performance, and life expectancy. This is accomplished through the maintenance technique of complete disassembly of the item, inspection of all parts or components, repair or replacement of worn or unserviceable elements using original manufacturing tolerances and/or specifications and subsequent reassembly of the item.

(3) Operator, organizational, direct support, general support, and depot. The symbol X indicates the categories responsible for performing that particular maintenance operation, but does not necessarily indicate that repair parts will be stocked at that level. Categories higher than those marked by X are authorized to perform the indicated operation.

(4) Tools required. This column indicates codes assigned to each individual tool equipment, test equipment, and maintenance equipment referenced. The grouping of codes in this column of the maintenance allocation chart indicates the tool, test, and maintenance equipment required to perform the maintenance function.

(5) Remarks. Entries in this column will be utilized when necessary to clarify any of the data cited in the preceding columns.

c. Columns in the allocation of tools for maintenance functions are as follows:

(1) Tools required for maintenance functions. This column lists tools, test, and maintenance equipment required to perform the maintenance functions.

(2) Operator, organizational, direct support, general support, and depot. The dagger (†) symbol indicates the categories normally allocated the facility.

(3) Tool code. This column lists the tool code assigned.

A3-2. Maintenance by Using Organizations

When this equipment is used by signal services organizations organic to theater headquarters or communication zones to provide theater communications, those maintenance functions allocated up to and including general support are authorized to the organization operating this equipment.

Section II. MAINTENANCE ALLOCATION CHART

PART OR COMPONENT	MAINTENANCE FUNCTION	ECHELON O/C	ECHELON O	ECHELON DS	ECHELON GS	ECHELON D	TOOLS REQUIRED	REMARKS
OSCILLOSCOPE TEKTRONIX MODEL 543	service		X					
	adjust					X		
	test				X		7, 9	
						X	1, 2, 3, 4, 5, 6, 7, 8	
	replace				X		10, 11	
	repair				X		10, 11	
	align					X	1, 2, 3, 4, 5, 6,	
	calibrate					X	1, 2, 3, 4, 5, 6	
	rebuild					X	1, 2, 3, 4, 5, 6, 7, 8	Plus Depot Facilities

Section III. ALLOCATION OF TOOLS FOR MAINTENANCE FUNCTIONS

TOOLS REQUIRED FOR MAINTENANCE FUNCTIONS	ECHELON O/C	O	DS	GS	D	TOOL CODE	Serv	Type Class	Remarks
OSCILLOSCOPE TEKTRONIX '543 (continued)									
GENERATOR, ELECTRONIC MARKER AN/USM-108					†	1			5th Ech Only
VOLTMETER, METER ME-30/U					†	2	Army	A	
AUDIO OSCILLATOR TS-421/U					†	3	Army	A	
SIGNAL GENERATOR AN/URM-25D					†	4	Army	A	
SQUARE WAVE GENERATOR TEKTRONIX 107					†	5			5th Ech Only
VARIAC					†	6			5th Ech Only
MULTIMETER TS-352/U				†	†	7	Army	A	
TUBETESTER, ELECTRON TUBE TV-2/U					†	8	Army	A	
TUBETESTER, ELECTRON TUBE TV-7/U				†		9	Army	A	
TOOL KIT, RADAR & RADIO REPAIR TK-87/U				†	†	10	Army	A	
TOOL KIT, SUPPLEMENTAL, RADAR AND REPAIRMAN TK-88/U					†	11	Army	A	

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TECHNICAL MANUAL)
)
No. 11-6625-611-15)

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, D.C., 23 September 1966

This manual is published for the use of all concerned.

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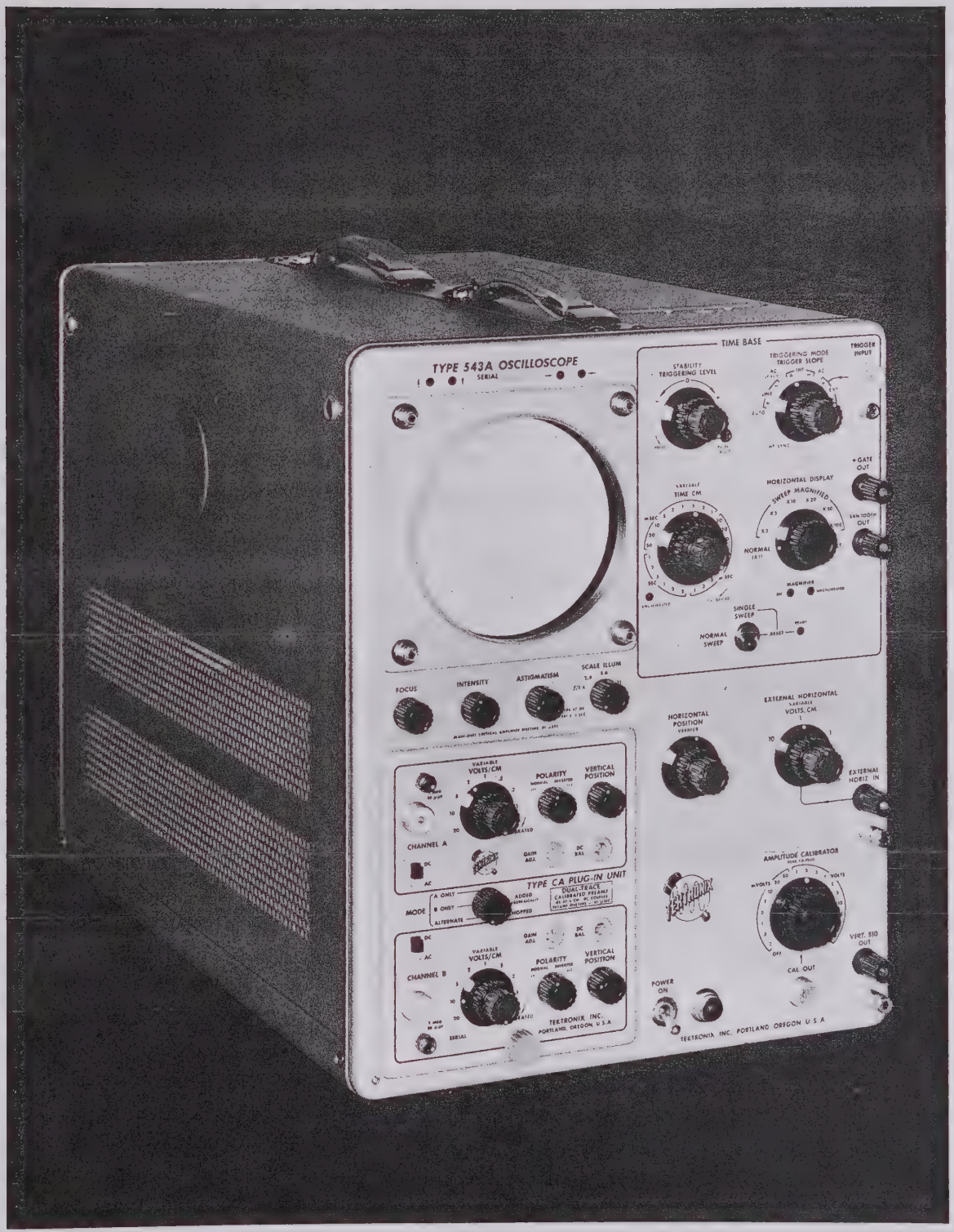
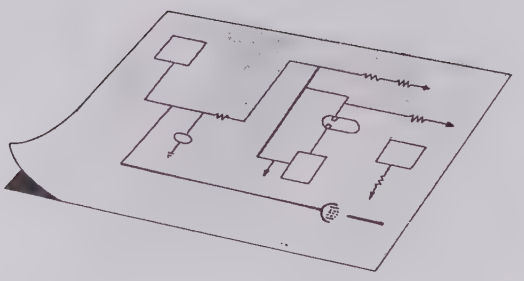
Section 2	Operating Information
Section 3	Applications
Section 4	Circuit Description
Section 5	Maintenance
Section 5.1	Preventive Maintenance Instructions
Section 6	Calibration Procedure
Section 7	Accessories
Section 8	Parts List and Schematic Diagram



Type 543/543A



SECTION 1

SPECIFICATIONS

General

The Tektronix Type 543/543A Oscilloscopes are general purpose instruments well suited to laboratory use. Plug-in preamplifiers are used in the vertical-deflection system, permitting the instruments to be used in many specialized applications, including, among others, wide band, dual trace, low level, differential, maximum frequency response and risetime, and transistor risetime checking. Specifications listed below apply to both the Type 543 and Type 543A, except in cases that are otherwise stated.

Vertical Deflection System

All specifications for the Vertical Deflection System of the Type 543 and 543A Oscilloscopes depend upon the plug-in unit used with the instrument. The following specifications are given assuming that a Type K plug-in unit is used.

Bandpass — DC to 30 mc (down 3 db $\pm$½ db at 30 mc)

Risetime — .012 microseconds.

Delay Line — Balance Network Signal Delay — 0.2 μsec

Horizontal Deflection System

Triggering Modes—Type 543, Automatic, AC Fast, AC Slow, DC and High Frequency Sync. Type 543A, Automatic, AC Low Frequency Reject, AC, DC and High Frequency Sync.

Triggering Signal Requirements

Internal — a signal producing 2 mm of vertical deflection

External — a signal of .2 volts to 10 volts, peak to peak. (The sweep will trigger on larger signals, but the TRIGGERING LEVEL control operates over a $\pm$10 volt range.)

Triggering Frequency Range — triggered operation to 5 mc.

Synchronizing Signal Requirements

Internal — a signal producing 2 cm of vertical deflection

External — a signal of 2 volts

Synchronizing Frequency Range — synchronized operation 5 mc to 30 mc.

Sweep Rates

Rates range between 0.1 microseconds to 5 seconds per centimeter in 24 accurately calibrated steps. An uncalibrated control permits sweep rates to be varied continuously between 0.1 microseconds and approximately 12 seconds per centimeter. Calibrated sweep rates are typically within 1%, and in all cases with in 3%, of the indicated sweep rate.

Magnifier

Six degrees of sweep magnification are provided; 2, 5, 10, 20, 50 and 100 times. Accuracy within 5% when the magnified sweep does not exceed the maximum calibrated rate of 0.02 microseconds/cm.

Unblanking

DC Coupling

External Horizontal Signal Input

Deflection Factor — Three calibrated ranges, .1 v/cm, 1 v/cm, and 10 v/cm. Continuously variable between ranges.

Frequency Range—dc to 500 KC in calibrated position.

Input Impedance — approximately 45 $\mu\mu$f paralleled by 1 megohm.

OTHER CHARACTERISTICS

Cathode-Ray Tube

Type T543/P2 — P1, P7 and P11 phosphors optional.

Accelerating potential — 10,000 volts.

Vertical Deflection Factor — approx. 7 v/cm.

Horizontal Deflection Factor — approx. 30 v/cm.

Voltage Calibrator

Square-wave output at approximately 1 kc.

Output Voltages — 0.2 millivolts to 100 volts peak-to-peak in 18 calibrated steps.

Accuracy — peak-to-peak amplitude of square waves within 3% of indicated voltage.

Power Supplies

Electronically regulated for stable operation with widely varying line voltages and loads.

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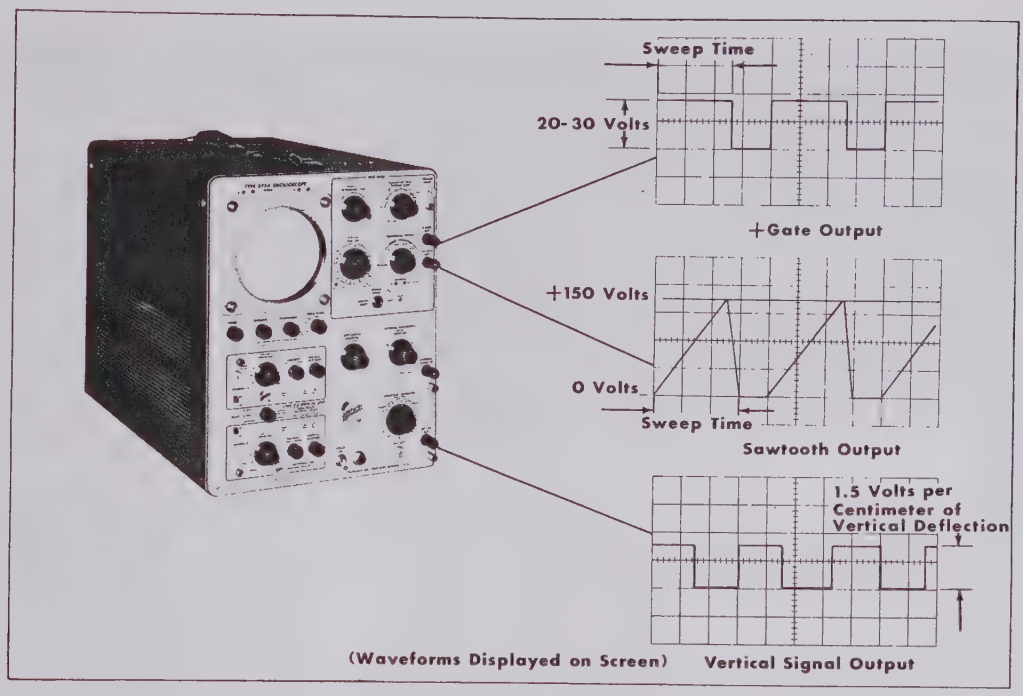


Fig. 1-1. Output waveforms available at the oscilloscope front panel.

Line voltage requirements — 105 v to 125 v, or 210 v to 250 v, 50 to 60 cycles.

Power — 500 watts with Type CA Plug-In Unit.

Output Waveforms Available

+Gate Output — approximately 20 volts peak-to-peak with same duration as sweep.

Sawtooth Output — Sweep sawtooth waveform, approximately 150 volts peak to peak.

Vertical Signal Output — output from vertical deflection system, approximately 1.5 volts peak to peak per centimeter of vertical deflection.

Mechanical Specifications

Ventilation — filtered, forced air. Thermal relay interrupts instrument power in the event of overheating.

Finish — photoetched, anodized panels. Blue finish, perforated cabinets.

Construction — aluminum alloy chassis and three-piece cabinet.

Dimensions — 24" long, 13" wide, 16¾" high.

Weight — 61½ pounds.

Accessories

2—Type P6006 Probes, 010-127.

2—Type A510 Binding Post Adapters, BNC, 103-033.

1 — Test Lead (012-031)

1 — Green Graticule Filter, 378-514.

2 — Instruction Manuals.

1 — 3 to 2-wire Adapter, 103-013.

1 — 3-conductor power cord, 161-010.

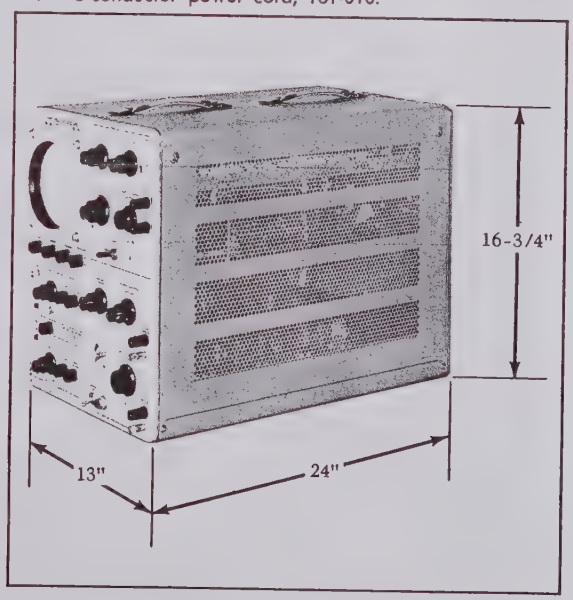


Fig. 1-2. Type 543/543A Oscilloscope Dimensions.

TABLE 1
PLUG-IN PREAMPLIFIER CHARACTERISTICS FOR TYPE 543/543A OSCILLOSCOPES

PLUG-IN TYPE	CALIBRATED DEFLECTION FACTOR	PASSBAND	RISETIME	INPUT CAPACITANCE
TYPE A Wide-Band DC Coupled	0.05 v/cm to 20 v/cm	dc to 20 mc	18 nsec	47 pf
TYPE B Wide-Band	5 mv/cm to 0.05 v/cm	2 c to 12 mc	30 nsec	47 pf
High-Gain DC Coupled	0.05 v/cm to 20 v/cm	dc to 20 mc	18 nsec	
TYPE CA Dual-Trace DC Coupled	0.05 v/cm to 20 v/cm	dc to 24 mc	15 nsec	20 pf
TYPE D† High-Gain DC Coupled Differential	1 mv/cm to 50 v/cm	dc to 2 mc	0.18 μsec.	47 pf
TYPE E Low-Level AC Coupled Differential	50 μv/cm to 10 mv/cm	0.06 cycles to 60 kc	6 μsec.	50 pf
TYPE G Wide-Band DC Coupled Differential	0.05 v/cm to 20 v/cm	dc to 20 mc	18 nsec	47 pf
TYPE H DC Coupled High-Gain Wide-Band	5 mvcm to 20 v/cm	dc to 15 mc	23 nsec	47 pf
TYPE K Fast-Rise DC Coupled	0.05 v/cm to 20 v/cm	dc to 30 mc	12 nsec	20 pf
TYPE L Fast-Rise	5 mv/cm to 2 v/cm	3 c to 24 mc	15 nsec	20 pf
High-Gain DC Coupled	0.05 v/cm to 20 v/cm	dc to 30 mc	12 nsec	
TYPE N* Pulse Sampling	10 mv/cm	600 mc	0.6 nsec	Input Impedance, 50 ohms.
TYPE P* is a fast-rise step-function test signal unit.				
TYPE Q* Strain Gage	10 μstrain/div to 10,000 μstrain/div	dc to 6 kc	60 μsec	Adjustable
TYPE R* Transistor Risetime	0.5 ma/cm to 100 ma/cm		12 nsec	
TYPE S* Semiconductor Diode Recovery	0.05 v/cm and 0.5 v/cm			
TYPE T* Time-Base Generator				
TYPE Z* DC Coupled Differential Comparator	0.05 v/cm to 25 v/cm	dc to 13 mc	27 nsec	27 pf

*More data available on the special-purpose plug-in units in the following paragraphs.

†At sensitivities greater than 0.05 v/cm, maximum bandpass is less than 2 mc. At 1 mv/cm, it is approximately 350 kc.

Type N

The Type N Sampling Unit is designed for use with Tektronix plug-in type Oscilloscopes. The sampling system thus formed permits the display of repetitive signals with fractional nanosecond (10^{-9} second or nsec) risetime. By taking successive samples at a slightly later time at each recurrence of the pulse under observation, the Type N reconstructs the pulse on a relatively long time-base. Specifications of the Type N include a risetime of 0.6 nsec, corresponding to a maximum bandpass of approximately 600 mc; a sensitivity of 10 mv/cm with 2 mv or less noise; and a dynamic range of ±120 mv minimum linear range before overloading results.

Accidental overload of ±4 volts dc is permissible.

Type P

The Type P Plug-In Unit generates a fast-rise step-function test signal of known waveform, simulating the output of an ideally compensated Type K Unit driven with a Tektronix Type 107 Square-Wave Generator. The Type P permits the standardization of the main-unit vertical amplifier transient response of a Tektronix convertible oscilloscope. Risetime of the Type P is approximately 4 nanoseconds when it is used to standardize a Type 543-Series Oscilloscope. Pulse repetition rate is 240 step functions per second, with either positive or negative polarity. Step function amplitude is continuously adjustable between 0 and 3 major graticule divisions.

Type Q

The Type Q Plug-In Unit permits any Tektronix convertible oscilloscope such as the Type 543/543A to be operated with strain gages and other transducers. Excitation voltages for the strain gages and transducers are provided by the plug-in unit. The unit provides high gain, low noise, and extremely low drift. Frequency response of the Type Q Plug-In Unit is DC to 6 kc; risetime is approximately 60 microseconds. Strain sensitivity is calibrated in 10 steps from 10 microstrain per major graticule division to 10,000 microstrain per division, and is continuously variable between steps.

Type R

The Type R Plug-In Unit is a combined power supply and pulse generator which is used to measure the high frequency characteristics of junction transistors by the pulse-response method. When the Type R is used in an oscilloscope having a delay line; delay time, risetime, storage time, and falltime may be displayed simultaneously. A pushbutton switch connects a front-panel terminal directly to the input of the oscilloscope for observing externally derived waveforms.

Pulse risetime of the Type R Unit is less than 5 nanoseconds, so measurements depend on the risetime of the oscilloscope used. Pulse amplitudes are in 8 fixed, calibrated steps from .05 to 10 volts, adjustable between steps. Pulse recurrence frequency is 120 pulses per second.

Type S

The Type S Plug-In Unit is designed for use with Tektronix Wide-Band convertible oscilloscopes. The slower risetime of the Tektronix 530-Series Oscilloscopes will affect the ability of the S Unit to analyze fast semiconductor diodes. Using the Type S, voltage across a test diode is displayed as a function of time.

Certain diode parameters, such as junction resistance, junction capacitance, and the stored charge at the junction, can be measured readily and reliably from the display. Performance of a diode in a particular circuit can be predicted by analyzing the recovery and "turn-on" characteristics. Since it is essentially a means for plotting voltage across an element while passing constant current through it, the unit can be used for other applications as well. For example: observing the junction characteristics of transistors, or measuring the resistance, capacitance or inductance of circuit components.

The Type S offers calibrated forward currents in five fixed steps from 1 to 20 milliamps, and reverse currents calibrated in six steps from 0 to 2 milliamps. Diode shunt capacitance is 9 picofarads, and deflection factors are 0.05 v/cm and 0.5 v/cm, calibrated.

Type T

The Type T Time-Base Generator provides sawtooth sweep voltages from 0.2 μsec/div to 2 sec/div. The trigger source may be line frequency, external, ac or dc coupled, automatic or high-frequency sync. The triggering point can be on either rising or falling slope of the waveform, and triggering level is adjustable. A signal of 0.2 to 50 volts is required for triggering.

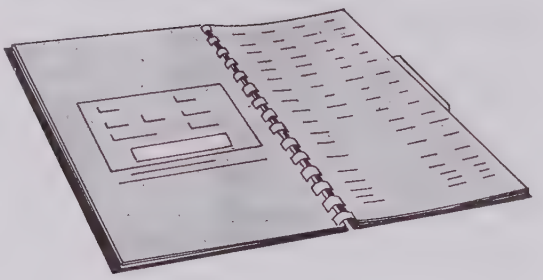
Type Z

The Type Z Plug-In Unit extends the accuracy of oscilloscope voltage measurements. It can be used in three modes of operation: (1) as a conventional preamplifier, (2) as a differential input preamplifier, or (3) as a calibrated differential comparator. With sensitivity of 50 mv/cm and insertion voltage range of ±100 volts, the effective scale range is ±2000 cm. Maximum resolution of the Type Z Unit is .005%.

As a conventional preamplifier, the Type Z Unit offers a passband of dc to 13 mc for the 543/543A for signals that do not overscan the screen. The deflection factors are 0.05 volts/cm to 25 v/cm in 9 fixed, calibrated steps.

As a differential input preamplifier, the Type Z accepts a common-mode signal level ±100 volts with input attenuation X1, and offers a common-mode rejection ratio of 40,000 to 1. Maximum input signal is 1 volt/7 nsec, or —1 volt/5 nsec.

As a calibrated differential comparator, the Type Z makes available three comparison voltage ranges; from zero to ±1 volt, zero to ±10 volts, and zero to ±100 volts.



SECTION 2

OPERATING INFORMATION

General

The Type 543/543A Oscilloscopes are extremely versatile instruments which are adaptable to a great number of applications. However, to make full use of the instruments, it's important that you understand the operation and the function of the various controls. This section of the Manual is designed to give you this information.

PRELIMINARY INSTRUCTIONS

Cooling

A fan maintains safe operating temperature in the Type 543/543A by circulating filtered air over the rectifiers and other components. When in operation, the instrument must be placed so that the air intake at the back is clear of any obstruction that might impede the flow of air. Side panels should also be in place for proper air circulation. The air filter should be kept clean in accordance with cleaning instructions found in the Maintenance Section of the manual.

Under no circumstances should your Type 543/543A oscilloscope be operated without the fan running. Without the fan, inside temperature of the oscilloscope will rise to a dangerous level in five to ten minutes. In this event, the thermal cutout switch will disconnect the power and keep it disconnected until the temperature drops to a safe level.

Power Requirements

Unless tagged otherwise, this instrument is connected at the factory for operation at 105 to 125 volts, 50 to 60 cycles AC (117 volts nominal.) However, provisions are made for easy conversion to operate at 210 to 250 volts, 50 to 60 cycles (234 volts nominal).

The power transformer (T700 in Type 543, T601 in Type 543A) is provided with split input windings, normally connected in parallel for 117 volt operation, but which can be connected in series for 234-volt operation. Each of these split windings terminates in a nest of four terminal lugs (arranged in a square) on the underside of the transformer. The lugs are numbered 1, 2, 3 and 4 in a clockwise rotation.

Terminals 1 and 3 are connected to one winding and terminals 2 and 4 are connected to the second winding. The ac input leads are connected to terminals 1 and 4 for both 117-volt and 234-volt operation, so these connections do not have to be changed when converting from one line voltage to the other.

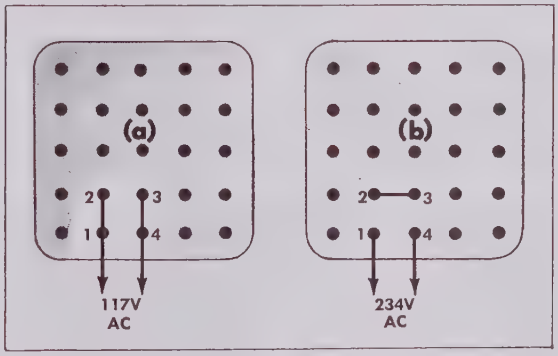


Fig. 2-1. Converting the power transformer from 105-125 volt operation to 210-250 volt operation.

When wired for 117-volt operation, terminals 1 and 2 are joined by a bare bus wire, and terminals 3 and 4 are similarly joined, as shown in Fig. 2-1a. To convert 234-volt operation, remove the bare bus wires between these terminals. Substitute a single connecting wire between terminals 2 and 3, as shown in Fig. 2-1b.

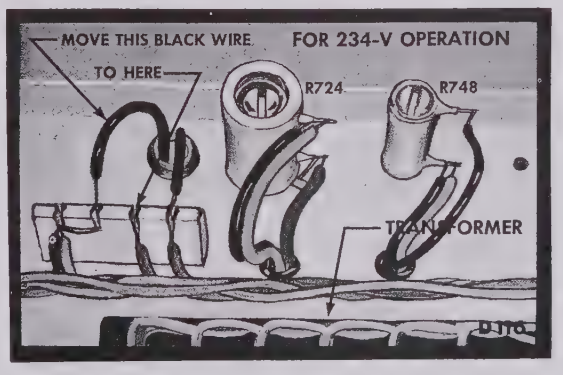


Fig. 2-2. Converting the Type 543 fan motor from 105-125 to 210-250 volt operation.

Fan Connections

The cooling fan is powered by a 117-volt ac motor. If the instrument is converted to operate from a 234-volt line, a change in the fan wiring must be made so that it operates from a 117-volt source.

In Type 543 Oscilloscopes, the leads that connect to the fan motor terminate in a four-terminal ceramic strip adjacent to the power transformer and to R724. The black wire closest to R724 is connected by another wire to terminal 3 of the power transformer for both 117-volt and 234-volt operation. This wire does not have to be changed when converting from one line voltage to the other.

The other black wire should be lifted free of the notch in which it is soldered and moved one notch closer to R724, as shown in Fig. 2-2.

In Type 543A instruments, to make the change from 117-volt to 234-volt operation, refer to the ceramic strip adjacent to one corner of the power transformer, as shown in Fig. 2-3. Unsolder the fan lead in the fifth slot at the ceramic strip, lift it free, and move it to the third slot as illustrated by the dotted line in Fig. 2-3. Use silver-bearing solder to solder the lead into the slot. The other fan lead connected at the second slot is not changed during the conversion from one line voltage to the other.

Fuse Data

Fuse data is silk-screened on the rear panel of the instrument adjacent to the fuse holder. Use only the recommended fuses for maximum over current protection.

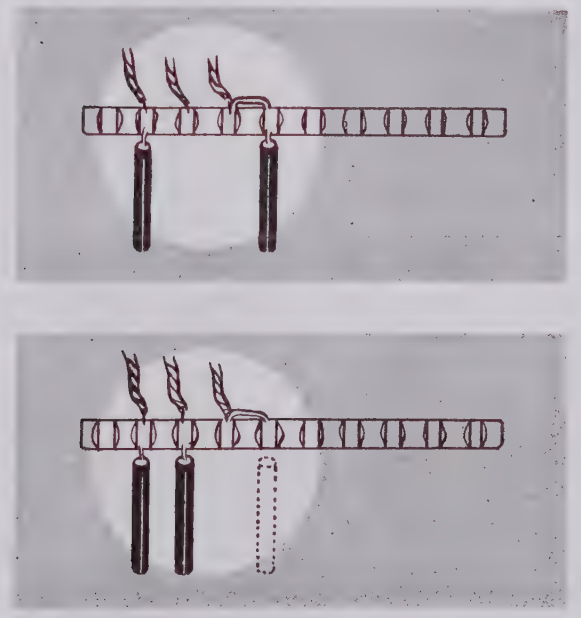


Fig. 2-3. Converting the Type 543A fan motor from 105-125 to 210-250 volt operation.

OSCILLOSCOPE OPERATING INFORMATION

Plug-In Units

The Type 543 and 543A Oscilloscopes are designed to operate with any one of the Tektronix letter-series plug-in units. The particular plug-in unit used must be selected by you to satisfy the requirements of your application. In selecting the plug-in unit for any particular application, you must consider the bandpass, sensitivity, and type of input required for that application. Complete information on all available plug-in units will be found in the Specifications section of this Manual.

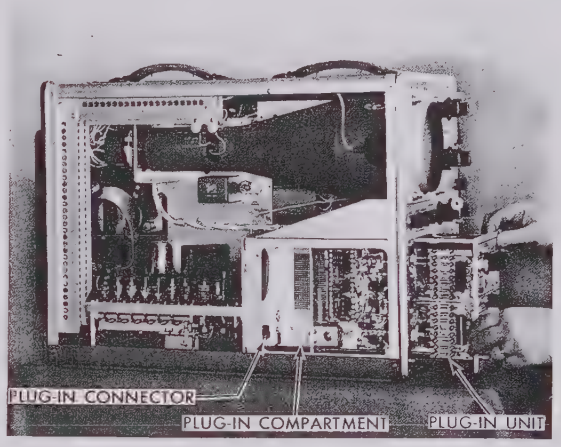


Fig. 2-4. Inserting the selected plug-in unit into the oscilloscope plug-in compartment.

Preparation for use

When the plug-in unit has been selected, insert it into the plug-in compartment of the oscilloscope and press firmly to insure that the connectors make proper contact (see Fig. 2-4). Tighten the plug-in unit locking control to hold the unit securely in place and turn the oscilloscope INTENSITY control fully counterclockwise. Connect the power cord to the rear of the instrument and to the power line and place the POWER switch in the ON position.

Time Delay

Time delay relays used in the Type 543 and 543A Oscilloscopes delay operation of the instrument for approximately 25 seconds after the POWER switch is turned on to allow a brief tube warmup period. The delay allows the tube sufficient time to heat before the dc operating voltages are applied.

If the ac power is off for only an instant, the normal 25-second delay will occur before the instrument returns to full operation. This delay will occur regardless of whether the ac power is off because of a momentary power failure or is turned off with the POWER switch.

TYPE 543A - TENT. S/N 4748
TYPE RM543A - TENT. S/N 1161

PARTS LIST CORRECTIONS

CHANGE TO:

R387	41.5 k	8 w	WW	1/2%	*310-614
R388	41.5 k	8 w	WW	1/2%	*310-614

EXPORT POWER TRANSFORMER

Transformer Primary

The instrument for which this manual was prepared is equipped with a special transformer. The transformer has eight primary terminals making possible six different input connections. The six primary connections are shown in Fig. 1.

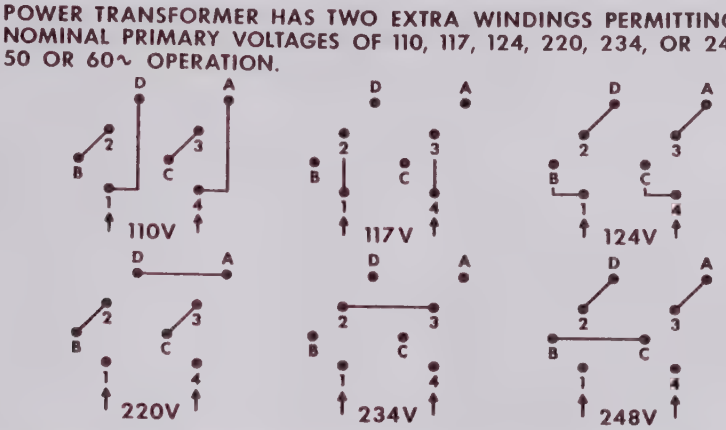

POWER TRANSFORMER HAS TWO EXTRA WINDINGS PERMITTING NOMINAL PRIMARY VOLTAGES OF 110, 117, 124, 220, 234, OR 248 V, 50 OR 60~ OPERATION.
110V
117V
124V
220V
234V
248V

Fig.1. The power transformer has two extra windings permitting nominal primary voltages of 110, 117, 124, 220, 234, 248 volts, 50 or 60 cycle operation.

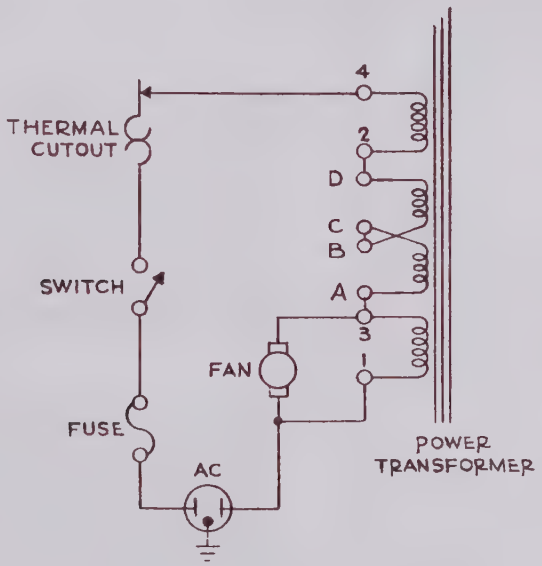


Fig. 2. When connecting the power transformer for operation with a supply voltage of 200 volts or more, be sure that the fan is connected between pins 1 and 3 of the primary. This is to insure that the fan is supplied with no more than 125 volts. Fig. 2 shows a typical high-voltage fan connection, using as an example the wiring for a 248 volt supply.

By Order of the Secretary of the Army:

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General, United States Army,
Chief of Staff.

Official:

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NAAD (5)
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SVAD (5)
Svc Colleges (1)
11th Air Aslt Div (3)
Gen Dep (1)
Sig Gen Dep (4)
Sig Dep (6)
USACRREL (2)
Ft Monmouth (10)
Ft Huachuca (1)
Ft Carson (7)
Ft Knox (12)
Ft Meade (2)
Ft Lawton (2)
Ft Heath (2)
Ft MacArthur (2)
Units org under fol TOE:
  11–155 (2)
  11–157 (2)
  11–158 (2)
  11–587 (2)
  11–592 (2)
  11–597 (2)

NG: State AG (3).

USAR: None.

For explanation of abbreviations used, see **AR 320–50.**

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